FIELD ARCHAEOLOGY

by

R. J. C. ATKINSON

WITH 12 HALF-TONE PLATES, 78 DIAGRAMS IN THE TEXT AND A FOLDER

METHUEN & CO. LTD. LONDON
36 Essex Street, Strand, W.C.2

First published November 7th, 1946
Second edition, revised, 1953

2.1

CATALOGUE NO. 3256/U

PRINTED BY LITHOGRAPHY IN GREAT BRITAIN
BY JARROLD AND SONS LIMITED, NORWICH

PREFACE

I HAVE been prompted to write this book by my own early experiences as an amateur of field archaeological research. In common with many other students of archaeology in this country, I have received little direct instruction in field methods, and such knowledge as I have gained has for the most part been picked up piecemeal.

Experience in the field is, I am convinced, the only possible form of training for the archaeologist, and I have nothing but gratitude for those under whose guidance I have worked, and from whom I have learnt much that is written in this book. Yet, however willing he may be to help and encourage the beginner, the professional archaeologist directing an excavation or controlling a museum department can ill spare the time to give much detailed direct instruction, and the would-be enthusiast may in consequence be left to grope his way slowly along unfamiliar paths.

For this reason it seemed to me that an elementary manual was needed, to explain the main principles and methods of field archaeology to the amateur student. In attempting to write such a manual I have been fully conscious that there are many who could have done so with far greater skill and greater authority than I; that none of them has done so is the only justification for attempting the task myself.

The purpose of this book is not to give detailed instructions for tracing Roman roads or excavating prehistoric earthworks. Text-book instruction upon such matters is impossible, because every archaeological problem must be treated differently, according to its own needs and the available resources of time, money, and labour. My aim has been rather to give an outline of the *general* principles and methods of research which are universally applicable, and with which the amateur student should be familiar, in order that his early experience in the field may profit both himself and those under whose guidance he works. I have included much elementary information, which

the more experienced reader may consider superfluous, in the belief that, in a book primarily intended for beginners, it is better to begin at the beginning.

I have written throughout with reference to work within the British Isles, and with special emphasis upon small-scale operations, carried out by only a few workers, in which the amateur archaeologist can most often be of service. These, to the general public, are naturally an aspect of archaeology less well known than such great enterprises as the excavation of Colchester or Maiden Castle; nevertheless it is upon the results of such small-scale operations that the bulk of our modern archaeological knowledge is founded.

In matters of principle there is no difference between the large operation and the small one; the difference lies rather in matters of organization. For whereas on a large undertaking there can be some division of labour, and the specialized work of surveying, recording, and photography can be made the business of experts with adequate time and assistance, in small-scale work these same tasks may all fall to the man in charge, in addition to his other responsibilities. Small-scale operations, therefore, whether in excavation or field-work, require the simplest and quickest procedures compatible with accuracy. It is, therefore, upon such simple procedures, and upon simple instruments and equipment, that I have concentrated here.

To any readers of this book who have no previous acquaintance with archaeology I add a final word. Because this book, as a text-book, may seem a dull book, do not imagine that archaeology is a dull subject. My concern here is, literally, with the spade-work of archaeology; it is no part of my purpose to describe its fascination. Those who wish to know something of that fascination should read Sir Leonard Woolley's book, *Digging Up the Past*, or Professor Gordon Childe's *Man Makes Himself*. Better still, let them join their local Archaeological Society, take part in some actual field research, and find out for themselves.

R. J. C. A.

OXFORD,
February 1946

PREFACE TO THE SECOND EDITION

IN preparing this second edition I have had much encouragement from friends, reviewers and correspondents too numerous to mention individually. With their help I have tried to remedy some of the major defects of the first edition, and to include in my treatment the special problems of archaeological field-work in the highland zone of Britain, of which my direct experience is only recent. I am very conscious, however, that many lacunae remain, and for these I alone am responsible.

As in the first edition, I have deliberately avoided discussion of the detailed treatment of particular types of site, and of the problems raised by the great variety of subsoils which may be encountered in the British Isles. To deal adequately with these matters requires a far wider experience (and, incidentally, far more space) than that at my command; and in a manual of this kind it seems preferable to keep silent rather than to risk misleading the unwary by writing at second hand.

New matter has been added in this edition on air-photographs, resistivity-surveying, photography, and a number of minor topics throughout the book; there are also four additional plates and eight new line-illustrations. To avoid any undue increase in price the original text has been shortened by the removal of the select bibliography of excavated sites and of a part of the chapter on surveying.

R.J.C.A.

EDINBURGH,
July 1950

CONTENTS

ACKNOWLEDGMENTS

FOR permission to reproduce illustrations my thanks are due to the following: Messrs. J. H. Steward, Ltd., for Figs. 54–9; the Ashmolean Museum, Oxford, for Plates I–IV, from air-photographs taken by the late Major G. W. G. Allen, and for Plate X; the Council of the Society of Antiquaries, for Plates Va and VIII; Sir Cyril Fox, for Plate VI; the Air Ministry, for the air-photographs shown in Plate IX; and Mr. F. R. Maddison, for Plate XII.

My warmest thanks are due to Mr. J. J. Leeming, for his expert criticism of the chapter on surveying; to Miss J. M. Morris and Mr. A. Snelling, for much valuable advice; to Dr. G. E. Daniel, Dr. J. K. St. Joseph, Mr. C. W. Phillips and the Air Ministry, for information about air-photographs; to the Director-General and the Archaeology Officer of the Ordnance Survey, for information about the post-war programme of the Survey.

In the preparation of the second edition I have been greatly helped by frequent discussions with Professor and Mrs. Stuart Piggott. Above all, I wish to record my very great debt to Mr. D. B. Harden for his encouragement and painstaking help in revising the manuscript and reading the proofs of the original edition, and to my wife for her constant assistance and advice at all stages in the preparation of this book, and especially in compiling the index.

INTRODUCTION

THE PAST

FIELD ARCHAEOLOGY is a young branch of learning, with a history of only three centuries. It is true, of course, that there existed even earlier an interest in antiquity; but it was an interest focused more upon genealogy, arms, heraldry, early political institutions, and kindred subjects, than upon the objects and monuments which are to-day considered to be the proper study of the field archaeologist.

The history of archaeological research in Britain can be divided into three main stages. The first of these, the period of record, occupies the seventeenth and eighteenth centuries, and is typified by the work of John Aubrey (1626–1697) and William Stukeley (1687–1765). Their accounts of ancient monuments, and their speculations upon their significance, reflect the rise of a conscious antiquarianism, and the gradual recognition of the value of material remains as a source of historical evidence; but the contemporary growth of practical experiment in the natural sciences had not yet extended to archaeological studies, and even in the latter part of the eighteenth century excavations were a rarity.

The second stage, the period of collection, belongs to the nineteenth century. The work of Cunnington and Colt Hoare in Wessex in the early years of the century initiated a spate of excavations, whose sole object was the collection of relics. For the most part the digging was little better than treasure-hunting, and inevitably destroyed much valuable evidence whose importance was not appreciated. But from the classification of the mass of material thus recovered grew the typological method which is the basis of archaeological studies; and the ideas of evolution and stratification, drawn from the growing sciences of biology and geology, were now applied to archaeological material, and so transformed the mere collection of specimens into a distinctive and recognised branch of historical research.

The third stage in the history of British archaeology may be called the period of scientific methods, and dates from the

introduction by Pitt-Rivers at the end of the nineteenth century of specialised techniques for the examination of ancient sites and for the recording of archaeological evidence. Pitt-Rivers was so far in advance of his time that there has been but little progress since his death in the actual methods of excavation; but great strides have been made in other branches of research. On the one hand the topographical aspects of archaeology have been revolutionised by the development of air-photography and by the establishment of the archaeological branch of the Ordnance Survey; on the other, the application to excavated material of the analytical techniques of modern science has vastly increased the scope of archaeological interpretation. At the same time, there has developed a growing public interest in archaeology, reflected in the provision of university curricula in archaeological subjects, the publication of non-specialist journals and books, and in the establishment of official agencies for the recording and preservation of ancient monuments.

The modern conception of the value and significance of archaeology can be understood only in the light of its previous history; for this the reader is referred to Dr. G. E. Daniel's *A Hundred Years of Archaeology* (Duckworth, 1950), in which the advance of archaeology is fully discussed in relation to its dependence and influence upon contemporary thought.

THE FUTURE

The recent war and its aftermath have had a profound effect upon the course of archaeological research in the field, and upon the methods adopted for its organisation. On the one hand, there has been a great increase in the rate of discovery and destruction of ancient sites by military installations and civil construction works of all kinds; the examination of these threatened sites, even in the most hasty and incomplete fashion, is likely to tax the resources of British archaeology for many years to come. On the other hand, the funds available for field research, from both public and private sources, have greatly diminished. These circumstances demand the co-ordination of archaeological activities of all kinds, if overlapping of effort is to be avoided and if the available resources of knowledge, skill and money are to be put to the best use.

This demand has been met by the creation of the Council for British Archaeology with its Regional Groups; and the *Survey of Policy and Research* published by this body clearly indicates the most profitable lines of future research.

It is evident, however, that whatever problems may be thought most worthy of investigation in themselves, the actual choice of sites for excavation will for many years be mainly limited to those that are threatened with destruction or damage. It is futile to suppose that the tide of destruction can be halted; but it may be well to consider briefly what are the further developments in archaeological organisation and technique that may prove most valuable under present conditions.

First, it is important that the search for archaeological remains, especially those not easily to be found by surface examination, should be greatly intensified; without this, many important sites will be lost, because they will be discovered only in the actual course of their destruction, when it is too late to examine them scientifically. For this purpose the new comprehensive air survey of Britain (p. 23) has already been of value in some districts, and it is essential that archaeologists should make the fullest use of this aid to research.

In excavation, every effort must be made to discover and develop techniques for the accurate location of buried structures, so that the minimum of time and labour is spent in purely exploratory trenching. In research work, especially in emergencies, serious consideration must be given to the use of mechanical excavators and other mechanical means of digging and removing soil.

Though rising costs and full employment are making the engagement of paid labourers increasingly difficult, there is fortunately no lack of volunteers willing to take part in excavations; and excavations staffed entirely by amateurs, even on a large scale, will become more and more common. The use of such labour, however, imposes upon the director of an excavation many extra responsibilities, and calls for much time and effort spent in organisation, instruction and supervision; it also demands an increase in the number of trained, but not necessarily professional, archaeologists who can act as supervisors and instructors for the beginners.

Perhaps the most important condition of future progress is much closer co-operation between archaeologists and scientists. Most of the field archaeologist's work will always depend for its success upon the skilled use of hand, eye and judgement, aided only by simple tools; but if techniques exist or can be invented, which can shorten the work or provide new knowledge not otherwise to be gained, then it is the archaeologist's duty to investigate them and to use them. The development of such new methods, both for the discovery and examination of sites and for the analysis of specimens and objects found, requires that the excavator shall know enough of the techniques of modern science to recognise problems which can be solved by experts in those techniques; and it requires equally that scientists should be aware of the problems that concern the archaeologist, and of the possibility of deriving from archaeological sources evidence relative to their own studies.

ARCHAEOLOGICAL TRAINING

We have already mentioned the growing need for archaeologists who have undergone an organized course of training, and we may consider briefly here what that training should be. It would perhaps be overstating the case to say that archaeologist are born, not made; nevertheless there are certain qualities required for archaeological field-work which cannot be acquired by instruction alone.

Foremost among these is the power to observe, and, moreover, to observe *critically*, to be able to distinguish the important from the trivial. Next comes the ability to record what is observed accurately and neatly and objectively: there is no place in archaeology, any more than in other sciences, for intellectual partiality in the choice of facts. Finally, the archaeologist needs both a broad and a scientific outlook; broad, to understand his work not as a subject contained in itself, but as just one aspect of the wider study of man; and scientific, to realize clearly the purpose and limitations of his methods, and the meaning and value of his evidence.

On the technical side of training the first requirement is obviously a thorough knowledge of the material remains which are the subject-matter of archaeology; and this knowledge must

be gained not merely from reading, but from actual seeing and touching. The second requirement, equally important, is a real knowledge of maps; and it is a geographer's, not a motorist's, knowledge which is needed. As an excavator, the archaeologist must have a sound grasp of methods, based upon actual experience, and besides being able to dig himself, he must be capable of training and directing others in digging. As a surveyor, he should be thoroughly conversant at least with simple procedures and instruments, and he should clearly understand the meaning and place of errors, and the necessity and means of checking his measurements.

In addition, he should be able to follow a simple but sure method of recording his finds, and to devise special methods of recording when necessary; he should also have some knowledge of how to give first-aid to finds discovered in a damaged condition.

For the task of interpreting his finds he should have a clear understanding of the value of archaeological evidence, and at least an elementary knowledge of cultural and social anthropology. In particular, he should know something of the methods and tools of all the more common crafts, especially pottery-making, as practised among primitive communities to-day.

In addition to his own subject, he should know something of other sciences: geology, botany, soil-science, zoology, metallurgy, and physical anthropology; more than an elementary knowledge of each is, of course, impossible; but that much at least is needed to enable him to see problems in his own work which may be answered by experts in those sciences, and to understand the implications of the answers which the experts provide.

Finally, the archaeologist must be able to write for publication lucid and objective accounts of his researches, free from jargon and intelligible to the ordinary reader. Equally important, he should be able to illustrate his reports adequately, or at least be sufficiently conversant with the processes involved in archaeological draughtsmanship and publication to direct the work of a competent draughtsman.

FIELD-WORK

To those not acquainted with archaeology that term is usually synonymous with excavation; it is not generally realized how much archaeological research is carried on which has no direct connexion with digging things up. This kind of work is generally known as field-work, and is concerned very largely with maps, which, it should be noted, are instruments of research quite as important as the spade and shovel.

The whole purpose of archaeology is to study the past history of man as revealed by his material remains. But man cannot be studied apart from his environment, apart, that is, from the countryside in which he lives, the food he hunts or grows, the climate he enjoys, and the natural resources which he utilizes. Among primitive communities especially, such as are those which archaeology studies, geographical environment plays a decisive part; for it is this which determines settlement areas and food supplies and the size and growth and movements of populations, and hastens or delays the diffusion of new ideas and new techniques from one community to another.

If, therefore, we are to study man, we must study him geographically. This profound truth has long been preached by Mr. O. G. S. Crawford, who has been responsible more than any one for putting archaeology in this country, literally, on the map. Those who wish to know what field-work really is should read his book, *Man and his Past*; they should also read Sir Cyril Fox's two books, *The Archaeology of the Cambridge Region* and *The Personality of Britain*, which illustrate admirably the thesis that the geographical approach is the only possible one.

It is, perhaps, not untrue to say that the fundamental importance of field-work has not been sufficiently appreciated even by archaeologists themselves. It is naturally more exciting actually to dig things up than to plan earthworks, trace ancient roads, and study distributions. But archaeology is a space-science no less than a time-science, and neither aspect can be studied without the other. Under present circumstances the discovery and recording of sites is far more important than

excavation. The impending destruction of monuments will continue to give frequent opportunities for digging; but, rescue-work apart, there are still many excavations which it is difficult to justify, and the effort expended on them might well be directed into more profitable, and less destructive, work.

Besides its own intrinsic importance, field-work is invaluable as a first training for the student. The beginner in archaeology can make no better start than to take a set of large-scale maps of a district and work over the country with them on foot, noting all the archaeological features, and plotting the distribution of soils and types of vegetation. Such an exercise, besides giving excellent training in observation, will do much to inculcate the geographical approach to archaeology.

EXCAVATION

The first principle of excavation is that it should never be undertaken except by an experienced person. For, as Sir Flinders Petrie has said, 'to suppose that excavating—one of the affairs which needs the widest knowledge—can be taken up by persons who are ignorant of most or all of the technical requirements, is a fatuity which has led, and still leads, to the most miserable catastrophes. Far better let things lie a few centuries longer under the ground, if they can be let alone, than repeat the vandalism of past ages without the excuse of being a barbarian'.

Indeed, excavation is not a simple matter. It does not consist merely in digging things up. For the archaeologist digs not for objects but for knowledge, knowledge which can only be won if digging is carried out systematically, according to certain obvious principles.

In any place which has been inhabited or used by an ancient community, objects which are lost or thrown away will gradually be covered up by later deposits, and structures will likewise fall into ruin or be silted up; so that in the course of centuries the whole site will become buried or obscured. It is the excavator's task to remove all these deposits in the reverse order to that in which they were laid down, so that each successive

stage in the history of the site may be revealed. It will be obvious, therefore, that digging must be so conducted that each object found can be seen in its own deposit, and a record made of the positions of the separate deposits relative to each other.

The excavator, moreover, must not only be able to *dig* carefully and skilfully; he must also clearly understand what his digging reveals. For excavation is, more than anything, destructive, and evidence not seen and recorded when first uncovered will be destroyed for ever when digging proceeds. It is precisely for this reason that no excavation should ever be undertaken by an inexperienced person, except under careful supervision. For however keen the student may be, without experience he cannot recognize the value of what he sees, and will, through ignorance, destroy it for ever.

This is not to say, of course, that the inexperienced student should only be assigned to the most trivial and harmless tasks on an excavation. On the contrary, there are certain types of archaeological site, notably travelling earthworks (dykes) and Roman roads, which are admirably suited for excavation by beginners under the minimum of supervision, especially since such excavation would probably be undertaken as a complement to previous field-work. On these sites the layers are usually distinct and easy to follow, and the normal scarcity of finds encourages concentration. (Many archaeologists would advocate a Romano-British occupation-site as the best training-ground for the beginner in excavation. The variety of structural and other problems presented by such sites is certainly advantageous to the serious student undergoing a systematic course of archaeological studies; but to the amateur beginner, especially if young, the profusion of finds may encourage a certain carelessness and indifference. On sites of other periods finds are relatively scarce, and require more concentration and care in their treatment.)

The destructiveness of excavation imposes limitations on the activities of the beginner and the expert alike. Not even the most experienced excavator can extract *everything* from a site; something must always escape him. Yet archaeological tech-

nique is constantly improving, and it may well be that the excavators of the future will think our present methods as inadequate as we think the methods of the 'barrow-diggers' a century ago. They may be able to recover what we to-day lose. For this reason, therefore, we should hesitate to excavate unless we can be reasonably certain of gaining thereby new knowledge. We should in fact follow in general the advice of the late Professor R. G. Collingwood, to dig only in order to find the answer to a specific question.

The type of excavation advocated by Professor Collingwood is *selective*; it serves, that is, to give the main facts about the culture and chronology of a community, without going into details. It needs relatively little work, time, and money to excavate a site in this fashion, and for these reasons it is the most common type of excavation practised in this country.

Selective excavation, however, is not enough, for it provides only a skeleton of knowledge. From time to time something more is needed, to enable us to see the life and history of a typical community in all its details. For this purpose, therefore, there must be *total* excavation, the stripping of an entire site, layer by layer, down to bed-rock. This operation, unlike selective excavation, does not seek to answer any specific question about the site; rather, it seeks to answer all the possible questions.

The majority of sites may be excavated either selectively or totally, provided the necessary resources for the latter method are forthcoming (and it may be observed here that if in the future we are to carry out total excavations on the necessary scale, far greater public support will be needed than has hitherto been the rule); one type of site, however, should always be excavated *totally*, namely, barrows. A barrow is a single entity, made at one time for one purpose; its real significance can only be understood if there is a similar unity and completeness in its excavation.

Two other types of excavation require mention here. The first is *rescue-work*, the salvage, that is, of archaeological sites which are being destroyed or threatened with destruction by building, quarrying, or the like. Here, very often, there is no

question to be answered, except, 'What, if anything, is there here, and what, if anything, can be saved?' Usually the work consists of rapid searching of the ground by trial trenches, designed to recover as many facts as possible in the minimum of time. For this, obviously, the quickest and simplest methods of work are needed.

Finally, there is *re-excavation*. We have already mentioned the many sites, particularly barrows, which were excavated, for the most part very unscientifically, during the nineteenth century. Often the excavation was confined to a pit dug at the centre, leaving the greater part of the structure intact. It is certain that the careful and complete re-excavation of these mutilated sites would give interesting and valuable results, for, as has already been said, a barrow is a single complete entity, and can only be understood by complete excavation. Moreover, even where the central area has been disturbed the excavation of the remainder is not necessarily fruitless, since more recent researches in barrows have shown that the centre is by no means always the most interesting part.

The importance of making full and accurate records imposes upon the excavator a special responsibility. It should be realized that an excavation is not an experiment which can be repeated and checked by others, as an experiment in chemistry or physics can be; once the excavation is finished, no evidence of the observed facts remains except the records made at the time. For the truth and accuracy of these records the excavator is solely responsible.

No less important than the making of records is their publication. The duty of publishing a full account of the work is implicit in the act of excavating; indeed, it is not too much to say that arrangements should be made, whenever possible, *before* the start of an excavation, to ensure the proper and early publication of the results.

In publication there are three essentials. First, a clear, simple style, free from archaeological jargon and intelligible to the ordinary reader as well as to the archaeologist; second, a careful separation in the text of fact from hypothesis; third, really good illustrations. In archaeological publications space

is never abundant; a few well-designed and well-executed plans and photographs will give far more information than pages of textual description. The ability to write clearly and concisely, to prepare adequate illustrations for publication, and to pick out just what is needed for publication and no more, is one which the archaeologist should strive most earnestly to acquire.

The duty of proper publication implies also the duty of depositing the finds from an excavation in a safe but readily accessible place, that is, *in a public museum.* If it lies in his power, the excavator should never allow his finds to be added to a private collection, which, however well it may be catalogued and cared for (and many, unfortunately, are not), is never so accessible as a museum.

These then are the principles of field research in archaeology. In field-work, to think geographically; in excavation, to dig scrupulously, to observe understandingly, and to record promptly and accurately; to interpret evidence objectively; and to publish results adequately and without bias.

The following chapters describe methods by which these principles are put into practice in the field. Before the reader passes on to them, I would give him a final warning. This book is not entitled 'Archaeology Without Tears'; it is not a short cut to proficiency in field methods. That proficiency can only be acquired by experience in the field under competent personal direction, and neither this nor any other book can take the place of that experience.

PART I THE SEARCH FOR EVIDENCE

I. FIELD-WORK

THE importance of field-work, as distinct from excavation, cannot be too strongly stressed, for the aim of all archaeological research is the study of man, not in himself, but in his relations with his environment in time and space. In this study excavation provides the time-aspect; but no amount of the most scrupulous excavation can be of any value unless its results are studied in terms of space, in terms, that is, of the distribution of man's settlements, his field systems and his religious monuments, and of his environment in vegetation, climate, and topography.

Field-work may be defined as the search for and recording of antiquities, and the collection of data from which their contemporary environment may be reconstructed. More specifically it consists of such work as the tracing of prehistoric and Roman roads, dykes, and boundary ditches, the planning of ancient field-systems and the settlements attached to them, the recording upon plans and maps of earthworks of all kinds, and the search for monuments recorded by earlier writers and since lost or obliterated. Field-work may also include studies which are not all carried out in the field, but which deal nevertheless with the space-aspect of history, namely, the plotting of distributions of sites and objects of all kinds, and the restoration of primitive vegetation by means of geological maps.

MAPS

It should now be clear that the chief requirement of the field-worker is a thorough knowledge of maps and their uses. In these islands archaeologists are peculiarly fortunate in that the official maps of the Ordnance Survey Office, themselves among the best in the world, provide a fund of archaeological

information which is constantly revised and added to by the Archaeology Officers of the Survey, who also are in course of producing an invaluable series of purely archaeological maps.

Full details of the whole range of Ordnance Survey maps are given in three booklets published by the Survey, entitled *Description of the Small Scale Maps*, *Medium Scale Maps*, and *Large Scale Plans* respectively; these booklets also contain lists of all agents from whom Ordnance Survey maps can be bought.

Maps of the *1/625,000 series* (about 10 miles to 1 inch) cover the United Kingdom in two sheets, and illustrate subjects such as land utilisation, topography, types of farming, solid and drift geology, and the distribution of commercially-exploited deposits. Their chief archaeological use is for plotting distributions on a national scale in relation to their physical environment. The *1/4-inch series* is similarly useful for studying distributions on a regional scale.

The chief use to the archaeologist of the *1-inch maps*, apart from the ordinary business of finding the way, is in the study of the location of sites and of their relations to other sites and to the surrounding country. To visualize country from a contoured map needs more than a 'motoring' knowledge of maps. The best, and indeed the only way to learn to use the 1-inch map to the full is constantly to study it upon the ground which it represents, until the process of visualization becomes familiar and easy.

The 1-inch map is on too small a scale to allow of its use as a basis for surveys in field-work. It should not, however, be despised; it is extremely useful for preliminary reconnaissance work in tracing Roman roads, and in all cases provides the indispensable background for the more detailed information provided by the large-scale plans.

The new *1/25,000 series* of maps (about 2½ inches to 1 mile) fills the gap between the 6-inch and 1-inch series, and shows the same amount of detail as the former maps. It will be found useful for plotting linear antiquities such as roads and dykes, local distributions of settlements, field-systems, or surface-finds, and as a basis for relief-maps.

The *6-inch series* of maps is the most useful for the field-worker, since it shows all hedges, fences, walls and other features which cannot be included at smaller scales.

This is the ideal map for such field-work as the recording in detail of the course of Roman roads and travelling earthworks, and the plotting of field systems and barrows (Mr. L. V. Grinsell's well-known work on barrows was carried out on these plans), and in general as an archaeological index in map form. The scale is, however, too small for the map to be used as a basis for accurate surveys of earthworks, unless they are very large. This will be clear when it is realized that on this scale the thickness of a pencil line (1/50 inch) represents a distance on the ground of over 17 feet.

The plans of the *1/2500 series* (about 25 inches to 1 mile) are substantially the same in detail as those of the 6-inch series.

These sheets are somewhat bulky for ordinary field use, but are valuable, especially if folded or trimmed, for accurate planning of earthworks with a plane table. On this scale the thickness of a fine pencil line (1/100 inch) represents a distance of 2 feet on the ground; when using this map, therefore, no measurements need be taken closer than to the nearest even number of feet.

For built-up areas plans at the scale of *1/1250* (about 50 inches to 1 mile) are gradually being published. They show the same detail as the 1/2500 series, but with greater accuracy. They will be useful chiefly to the archaeologist concerned with the excavation and recording of Roman and mediaeval sites beneath modern cities.

THE NATIONAL GRID

All maps newly published by the Ordnance Survey, and all revisions of existing series, are over-printed with the National Grid. This is a system of rectangular co-ordinates numbered in kilometres in the margins of the sheets. With the help of the Grid it is thus possible to define the position of any point in the United Kindgom by a unique numerical reference. Brief instructions for finding the grid reference of a point are given in the margins or on the covers of the map sheets, and full details are published by the Survey in a booklet entitled *The Projection*

map-model might be based on the 1/25,000 series (p. 14). The vertical scale should be exaggerated two or more times, according to the general relief of the ground. Soil types, or natural vegetation based upon them, should be clearly indicated.

It is only on this type of map that the relief and the geology or vegetation can be adequately represented at the same time. Its construction will involve some labour, but there are few better ways of becoming thoroughly familiar with the physical characteristics of a region.

SURVEYING

Besides being able to read and understand maps and plans, the field-worker must be able to make them. The subject of archaeological surveying is dealt with in a later chapter; it will be enough to say here that since the field-worker will often be working alone, he should pay special attention to proficiency in those methods of survey which can be carried out single-handed.

For linear measurements pacing is the only satisfactory method for the solitary worker; the use of the measuring-tape is laborious, and should be restricted as far as possible to the measurement of bases and other important lines. Pacing need not be nearly as inaccurate as is often supposed. With constant practice over various slopes and types of ground, and comparison with the true distance as measured with a tape, it should be possible to work out a series of pace-factors by which paces can be converted to feet or yards. The error introduced by pacing should not exceed 3 or 4 per cent, which is suitable for most types of field-work.

AIR-PHOTOGRAPHY

(During the last twenty years the work of Mr. O. G. S. Crawford, the late Major G. W. G. Allen, and others, together with the co-operation of the Royal Air Force, has given archaeologists a new weapon of research, the air-photograph.) Indeed, the use of air-photography marks the greatest advance made in the technique of field archaeology since the introduction of scientific methods by General Pitt-Rivers, and the archae-

ological aspect of many areas has been completely changed by the discovery of hundreds of hitherto unrecognized sites.

The archaeological applications of air-photography have been fully described by Mr. Crawford in two Professional Papers of the Ordnance Survey, *Air Survey and Archaeology* and *Air Photography for Archaeologists*. A brief summary is given here of the various ways in which archaeological sites may become visible and be recorded from the air; for further details the reader is referred to Mr. Crawford's two monographs.

Fundamentally, all archaeological sites (and, of course, all non-archaeological disturbances of the ground) are revealed as differences of tone on a photograph. These tone differences are due to two causes, namely, differences in the reflecting power of surfaces on the ground, and actual differences in the colour of growing crops and grass, or of the bare soil. Sites made visible in the first way are known as *shadow-sites*; those revealed in the second way are called *crop-marks* and *soil-marks*.

SHADOW-SITES (Plate I)

These sites include the ramparts and ditches of hill-forts, boundary-ditches, barrows, and any other earthwork whose surfaces in relief are capable of casting a shadow. On sites where the relief is slight shadows are usually cast only in the early morning or late evening, when the sun is low; at these times details are often visible from the air which cannot be picked out at all by an observer on the ground.

Shadow-sites of another class may sometimes be seen in growing crops in July or August (Plate II). A crop growing over a silted-up ditch or pit may, owing to the greater depth of soil, grow high enough above the surrounding plants to cast a slight shadow, although, because of the ripening at that time of year, no difference of colour will be discernible, as might have been earlier in the season (*v. infra*, Crop-marks).

A third type of site may be included under this heading, although its appearance is due not to the casting of a shadow but to the unequal intensity of reflection from inclined surfaces. For instance, when lynchets (cultivation terraces) are photographed facing a setting sun, the sloping faces of the terraces,

being steeper than the general slope of the hill-side, and therefore more steeply inclined at right angles to the sun's rays, will reflect more light than the surrounding ground and will appear on the photograph as light lines on a darker background.

On rare occasions snow may show the position of earthworks in a striking manner. In a heavy storm with a driving wind, mounds and hollows will cause differential drifting of the snow. When the main blanket of snow has melted, the remains of the drifts will mark even very slight changes of relief, which can be recorded with great clarity by air-photography.

CROP-MARKS (Plates II, III, and IV)

Whereas the shadow-marks just described are all due to differences in the relief of the ground, which can always be detected by an observer at ground-level either by eye alone or by careful use of levelling instruments, crop-marks often betray the position of sites of which there is no indication in the surface relief at all. Photographs revealing crop-marks are therefore of particular value to the archaeologist.

Marks in crops (which term here includes pasture) are due to two causes, namely, differences in the colour and differences in the growth of the crop. Both these differences arise from disturbance of the ground in which the crop is growing. The growth and colour of a crop depends largely upon the amount of moisture and other nourishment which the plants can derive from the soil and subsoil. Where, therefore, the depth of soil has been increased by the digging and subsequent filling up of a pit or ditch, or by the heaping up of additional soil in the form of a bank, more nourishment will be available, which will be reflected in the rate of growth and colour of the overlying crop. Conversely, where the available depth of soil is decreased by the presence of impenetrable surfaces, such as walls, floors, and roads, the overlying crop will tend to be thin and stunted and lighter in colour. This weak growth may be shown either by patches of corn flattened by the wind, or by darker or lighter areas where the soil shows more clearly through the thin crop (Plate III).

Generally speaking, therefore, a well-defined dark mark in a crop may be taken to indicate a pit or ditch beneath the

surface, and a vaguer, more smudged mark a weathered bank; while a light mark, or patches of flattened grain, will probably overlie foundations or some other hard surface.

We may here include for convenience what may be called *soil-marks,* that is, differences in colour appearing in bare soil prepared for sowing. These differences are due to the spreading and exposure by the plough of material from banks, mounds, and even walls and floors, which shows up as a lighter patch contrasting with the darker plough-soil around it. The effect is particularly marked in chalk country (Plate IV).

All the contrasts described above are intensified by parching of the ground in a hot dry summer. The effect is particularly marked on grass-land, where crop-marks normally only appear under such conditions (it may be noted, however, that the position of pits and ditches beneath grass is sometimes indicated not by differences in the grass itself but by the flourishing growth there of thistles and other weeds). Parching too will show the position of walls, roads, etc., as light patches on bare plough-soil, though usually only when the rough surface of the field has been smoothed out by rain some time beforehand.

Changes of tone analogous to crop-marks and, like them, indicating the position of buried ditches and pits, have occasionally been seen when the ground is completely covered with snow. The effect is evidently due to the relatively greater thermal conductivity of the ditch-filling, which causes the overlying snow to melt faster than on undisturbed ground.

The degree in which soils and crops are capable of producing visible marks is variable. Generally speaking, crop-marks do not appear where the soil and underlying 'rock' are of similar consistency, as is the case with clay and sand. Disturbances in harder 'rocks' such as chalk, gravel, and limestone will produce marks, but only if the topsoil is comparatively shallow. Crops, too, vary in sensitivity; grass rarely shows any marks, except under parched conditions, while among grain crops oats, and among leguminous plants lucerne (alfalfa), is probably the most sensitive.

It will be clear, therefore, that the absence of crop-marks does not necessarily indicate an area archaeologically barren;

it may be due simply to the lack of suitable conditions. Conversely, by no means all crop-marks should be assumed to be of archaeological interest. Ditches may be relics of comparatively modern drainage systems; banks may mark the site of destroyed hedges or old plough headlands; and many a promising set of circular marks has turned out upon inspection on the ground to be nothing more than fungus rings. Even Mr. Crawford, the pioneer of archaeological air-photography, records how he spent a day discovering that some interesting 'barrow ditches' were in fact the result of circular browsing by tethered goats.

The moral of these examples is obvious. Observation from the air is a very valuable method of research, but it is not enough. Every site seen or photographed from the air should be visited on the ground as soon as possible, so that the observations may be checked. Until this has been done it is very unwise to speculate or to indulge in hopes which may easily be proved vain.

The cost to the archaeologist of taking his own air-photographs is very high. Charter-fees for a suitable commercial aircraft with pilot vary from £5 to £8 per hour. If a friendly member of a local flying club can be persuaded to act as pilot, the hire of a club aircraft may be as low as £3 per hour, or about £10 plus the cost of fuel, oil, and landing fees, if the machine is hired for a whole day. Moreover, successful air-photography has its own techniques, which can only be learnt by expensive experience.

Nevertheless in certain circumstances, particularly in the case of sites threatened with destruction that must be excavated in a hurry, a brief flight for observation and photography may yield information of the greatest value to the intending excavtor, and the time and expenditure thus saved in digging will more than offset the high cost of flying.

THE AVAILABILITY OF AIR-PHOTOGRAPHS

The chief sources of archaeological air-photographs are as follows:

1. *Individual collections*

(*a*) *University of Oxford.* The Allen collection housed in the Ashmolean Museum comprises about 1500 oblique views of

archaeological sites, located chiefly in the Oxford district and the South of England. The collection may be consulted and copies of prints purchased on application to the keeper of the Department of Antiquities. A collection of many thousands of war-time reconnaissance photographs illustrating archaeological and other sites in Europe is housed in the Pitt-Rivers Museum.

(*b*) *University of Cambridge.* A large and growing library of oblique photographs of archaeological and other sites in the United Kindgom is being formed. Applications to view the collection, and to purchase prints (in which preference is given to the needs of University and other research institutions) should be made to the Curator in Air-Photography.

(*c*) *Ordnance Survey Office.* The Archaeological Branch of the Ordnance Survey possesses a collection of pre-war vertical air-photographs illustrating archaeological sites in various parts of England. The collection may be consulted, and prints purchased (on payment of a reproduction fee) on application to the Archaeology Officer. Prints from the 1/10,000 National Air Survey (see below) may also be seen by arrangement at the Archaeological Branch.

(*d*) *Commercial air-survey companies*, such as Aerofilms Ltd., maintain large libraries of air-photographs which include archaeological subjects; these may be consulted and prints purchased on application to the company concerned.

2. *The National Air-Survey*

Since 1945 the whole of the United Kingdom has for the first time been surveyed from the air, and it is now possible to obtain vertical air-photographs of any area in England, Wales or Scotland. This material, being compiled for surveying and planning purposes, is naturally of less value to the archaeologist than photographs taken specially to record ancient sites. Nevertheless, the existence of comprehensive photographic cover has in effect revolutionised the application of air-photography to archaeological field-work, and no regional studies in archaeology can in future be regarded as adequate unless the fullest use has been made of these photographs.

At the present time photographic cover is available for virtually the whole of the United Kingdom, excluding the Isle of Man, the

Channel Islands, and all but a few coastal areas of Northern Ireland, at the scale of 1/10,000 (approximately 6 inches to 1 mile). For certain areas, chiefly large towns and their immediate environs, there is additional cover at the scale of 1/5,000. Many districts are covered by more than one series of photographs, taken at different times. Oblique views are also available of certain limited areas.

The R.A.F. Print Library at Medmenham, Marlow, Bucks., holds a complete reference series of all available air cover for the United Kingdom. Permission to visit the Library to consult prints is given in a limited number of cases; application should be made to the Under-Secretary of State, Air Ministry S.4(d), Whitehall, S.W.1, at least two weeks in advance. The Department of Health for Scotland in Edinburgh holds prints of all cover for Scotland, which may be consulted by the public during normal working hours without previous application. The Planning Departments of many Local Government authorities also possess cover of the area under their control, which can usually be consulted on application to the appropriate officer.

The unit of classification of prints is the *sortie*, that is, a series of prints taken on a single flight. Each sortie consists of one or more strips of prints, running approximately in an East-West direction, each print overlapping the next to East and West by about two-thirds of its width, and each strip overlapping those to North and South by a smaller and more variable amount. Each print measures 7 ins. wide by 8¼ ins. high, and is labelled at the top with the sortie-number, the date of the sortie, the focal length of the lens used, the height of the aircraft, and other service details; in the top left corner is a four-figure number, viz.

4368 CPE/UK/1974 11 Apr. '47. F. 20″. 16,400′ 58 Sqdn.

For identification purposes it is necessary to quote the sortie and print-number, e.g. CPE/UK/1974 4368.

Prints may be purchased from the Air Ministry by private persons and firms at 1s. 6d. each, and by certain learned societies and institutions at 9d. each; normally museums and national and local archaeological societies are classified in the latter category. These charges may be revised, and increased demand for prints may lead to a curtailment of the service.

Prints should be ordered from the Under-Secretary of State at the address given above, giving sortie and print numbers if these are known. Otherwise, the most convenient way of showing the area for which cover is required is to send with the order a tracing from the 1-inch Ordnance Survey map, showing the boundaries of the area, with sufficient detail in the form of sheet numbers or national grid references to enable the tracing to be located on the reference maps of the R.A.F. Central Photographic Establishment. In the case of an approximately quadrilateral area it will be sufficient to quote the grid references or latitude and longitude of the corners.

For the location of prints in relation to the map cover-traces are available; these are photographic reductions of the 1-inch maps with the edges of individual prints plotted and numbered upon them. They are issued free with prints at the rate of one part of the plot (a single sortie may be covered by a number of parts) to a minimum of 20 prints from one sortie; parts in excess of this free issue are charged at 2s. each. Sortie plots may be bought separately at the same charge per plot, in order to identify the serial numbers of the prints required.

Photographs of the national air survey are Crown Copyright material, and can only be publicly exhibited or reproduced if permission is first obtained from the Air Ministry at the address given above; in certain circumstances reproduction fees will be charged.

THE STEREOSCOPIC EXAMINATION AND INTERPRETATION OF AIR-PHOTOGRAPHS

It is well known that the ability to see objects as three-dimensional solids depends upon the fact that the two eyes register images which differ slightly owing to their separation. A single photograph cannot give a three-dimensional view since it incorporates only one image taken from a single view-point. If, however, two photographs of the same scene are taken from slightly different view-points, and if the prints are arranged so that the right eye sees only the right-hand image and the left eye the left-hand one, stereoscopic vision results and the two images will combine to give an impression of three-dimensional relief.

Any pair of vertical air-photographs which overlap one another will thus contain an area common to both which, if viewed so that each print is seen by one eye only, will be seen in stereoscopic relief. It is for this reason that prints of the 1/10,000 survey overlap each other, each adjacent pair showing a common area of ground approximately $\frac{3}{4}$ by $1\frac{1}{4}$ miles which can be examined stereoscopically.

Stereoscopic examination, since it adds a third dimension to the photographs, enables details to be seen which cannot be appreciated in a single print. Moreover, owing to the great separation in space between the view-points from which adjacent photographs are taken, the effect of three-dimensional relief in these photographs is enormously exaggerated, so that even very slight eminences and depressions on the ground are seen clearly in relief. For this reason it is essential that these photographs should be examined in pairs under a stereoscope; it is always undesirable, and often quite useless, to order single prints of individual sites.

It is possible with practice to view a pair of prints stereoscopically with the naked eyes alone, but it is liable to lead to eye-strain, especially for those with defects of vision. It is preferable to use a simple stereoscope of the type shown in Plate IX, which enables a magnified image to be viewed in comfort. The instrument consists of two positive (bi-convex) lenses whose separation is adjustable, fixed in a metal frame with folding supports. The lenses are adjusted so that the eyes look through their inner halves; the photographs are then placed so that corresponding points on their respective images lie beneath the centres of the lenses, and are orientated with respect to each other and to the stereoscope in such a way that a three-dimensional image results. Once proper orientation has been obtained the instrument may be moved about over the prints to examine different features in the area of overlap.

For proper interpretation of relief two conditions must be fulfilled. First, the photographs must be correctly positioned and orientated; if the positions of the prints are reversed right for left the relief will be inverted, heights being seen as depths and *vice versa*; advantage may occasionally be taken of this fact deliberately, in order to determine with greater certainty

whether a feature in very slight relief is in fact a depression or an elevation.

The second condition is that the apparent direction of lighting *in the prints* should correspond with the *actual* direction of lighting at the place where they are viewed. In the majority of these photographs the light comes from the bottom edge (i.e. the South), and they must therefore be viewed with this edge furthest from the observer and nearest to the source of light, which will be in front of him. Failure to do this may result in the apparent inversion of the relief seen. The correct arrangement of prints, stereoscope and light is shown in Plate IX.

Correct interpretation of archaeological features from stereoscopic pairs of prints can be learnt only with practice. Generally speaking, if the orientation and the lighting is correct, structures of marked relief will stand out with great clarity; but where the relief is only slight some difficulty may be found in deciding whether elevations or depressions are seen. In such cases the position of the shadows is the determining factor; in a pit or ditch, the shadowed side is nearest the source of light, and on a mound or bank, furthest from it.

Not only does stereoscopic examination of photographs enable structures to be identified that would be invisible to the naked eye of an observer in the air, and sometimes even to one on the ground also; it presents, in addition, a picture of the topographical setting of an ancient site that cannot be obtained in any other way. Moreover, even on quite flat ground, where sites show only as crop- or soil-marks, it will be found that the stereoscopic view will usually reveal more than can be seen on a single print. This applies also to the examination under a stereoscope of duplicate prints of the *same* photograph (e.g. an oblique aerial view); even though no real stereoscopic image is seen, a more satisfactory image of the photograph is obtained, especially if the observer is practised in the examination of stereoscopic pairs.

PLOTTING FROM AIR-PHOTOGRAPHS

Air-photographs may often serve usefully as a basis for archaeological plans and sketch-maps. For many purposes a simple tracing of the main features from a vertical photograph

will suffice, but it is desirable to know the limitations of accuracy of this method. A vertical photograph has the characteristics of a map only if the ground it portrays is flat and level, and if the photograph is taken in a strictly vertical direction; undulating ground and tilting of the camera introduce distortions of scale.

In the 1/10,000 survey the degree of camera-tilt is regulated within narrow limits, and distortions due to this cause may be neglected. Distortions due to surface relief are more serious; they arise because the tops of hills, being nearer to the camera, are necessarily reproduced in the photograph at a larger scale than the more distant bottoms of the valleys. Thus two structures of identical diameters but at different heights will appear to be of different size on an air-photograph; the maximum apparent change of size from this cause on any one photograph is unlikely to exceed 4 parts in 100. For accuracy of plotting it may thus be necessary to determine the scale of a photograph at more than one point on each print.

The scale of a vertical photograph may be found in three ways. In the first, the focal length of the lens used is divided by the height of the aircraft (in the same units) to give the required representative fraction (p. 210). Thus a photograph taken at 16,400 ft. with a 20-inch lens has a scale of $20 \div 16400 \times 12$, or 1/9840; but this is only a rough method of finding the approximate average scale of a print, owing to the continual variations in the actual height of the aircraft and of the ground.

The second method requires a map on which points visible in the photograph can be identified with accuracy. If the distance between two points on the map is A, the corresponding distance on the photograph B, and the representative fraction of the map 1/C, then the scale of the photograph is given by $B \div A \times C$.

In the absence of a map the scale of the photograph may be found if the length of an object appearing in it is known. Thus if the length of the image on the photograph is B, and that of the object, in the same units, is A, the scale of the photograph at that point is $B \div A$.

If a piece of semi-transparent tracing material, such as *Kodatrace* or *Ethulon* is placed over one print of a pair viewed

under a stereoscope, rough contours or form-lines can be sketched in to indicate the basic features of the relief.

Plotting from oblique air-photographs involves special techniques beyond the scope of this book. For details of these techniques, some of which can be used successfully by the layman on oblique photographs of flat country, the reader is referred to J. W. Bagley's *Aerophotography and Aerosurveying* (McGraw Hill, 1941) and L. G. Trorey's *Handbook of Aerial Mapping and Photogrammetry* (Cambridge University Press, 1950).

THE DETECTION OF BURIED STRUCTURES

The presence of archaeological remains is usually indicated either by visible differences in surface relief; or by differences in the colour of the soil or vegetation, which can be seen from the air and, less commonly, from the ground; or by the presence on the surface of potsherds, building debris, or other traces of human occupation. In all but the first case it will be necessary to locate accurately the position of the buried features before a plan can be made or an excavation undertaken.

A number of methods is available for this purpose. The simplest of them is *probing* with the instrument described on p. 48. To search a piece of unknown ground two parallel lines of pegs are set out 100 ft. apart, the distance between them depending upon the closeness with which the ground is to be searched. A 100 ft. measuring-tape is stretched between two opposite pegs, and the ground probed to the depth of the natural rock at equal intervals along it. The depth of bedrock at each point is recorded, and the position of sudden changes of depth marked with small pegs (e.g. white wooden gardener's labels). This method is laborious and tiring, and is limited to sites where the depth of topsoil does not exceed 3 ft. On sand and clay it will usually be difficult, if not impossible, to detect the change from topsoil to subsoil; but in sand the filling of the larger ditches may be found to give a 'sticky' feeling; while on both these subsoils, as on others, hard structures such as walls, floors, and road-surfaces will be readily detected. On sites where masonry or dry-stone buildings occur, the probe will show the general position and shape, but cannot usually detect the actual

walls, which will be indistinguishable from the rubble which surrounds them. In spite of these limitations, however, the probe remains the simplest and quickest means of locating shallowly-buried structures, and every field-worker would be wise to carry a probe in place of the more usual walking-stick.

Various forms of *auger* may be used to locate buried pits and ditches in soft soils, and particularly in sand; though slower in use, the auger will provide information about the composition of buried layers which cannot be obtained with the probe. The simplest form of auger consists of a $\frac{3}{4}$-inch steel woodworker's bit fixed in a wooden handle; the sawn-down handle of a spade is suitable; the total length should be about 30 inches. The chief use of this instrument is on sandy heathland sites, where occupation-layers may lie within 15 inches of the surface. At regular intervals over the area to be searched a small sod is removed with a spade, and at the bottom of the hole thus made the auger is screwed into the soil to a uniform depth, indicated by a mark on the handle. It is then pulled out, and the material held by the bit examined. In this way the position and extent of discoloured occupation-layers close to the surface can be plotted with fair speed and accuracy[1].

A more elaborate auger for use at greater depths again utilises a $\frac{3}{4}$-inch or 1-inch woodworker's bit. The square part of the shank is sawn off and the rounded part is threaded with a suitable whitworth screw-thread for a distance of about $1\frac{1}{4}$ inches from the end; a square or hexagon nut is screwed to the bottom of this threaded partion and welded in place. The shaft of the auger consists of two square-section bars of $\frac{1}{2}$-inch mild steel, each from 3 to 5 ft. in length, of which one or both can be used according to the depth of boring. The bars are tapped and threaded at the ends so that they can be screwed to each other and to the bit. The handle is a steel cross-bar with a central square perforation; it slides on the square shaft, and can be locked in any position by a set-screw.

In use, the auger is screwed into the ground until the bit is covered, and then withdrawn with a slight screwing motion in the same direction. The hole can be deepened in successive

[1] I am indebted to Lady Briscoe for information about this method, which she has practised with success on the sandy heaths of East Anglia.

stages in this manner, samples of soil being obtained at each stage, to a maximum depth of about 9 ft., depending on the length of the shaft.

Augers can be used successfully only in soft, fine-grained soils; they will not penetrate rubble or other coarse material.

For boring in peat a special auger is available, which is fitted with a sampling tube enabling a cylindrical core of peat to be obtained at a pre-determined depth.

Probes and augers should be used with great caution, if indeed at all, on sites such as cemeteries where there is a risk of damaging unsuspected objects.

There remain two other methods of detection, which do not depend for their effect upon the penetration of the soil. The first of these, known as '*bosing*', consists in percussing the surface of the ground with a weighted rammer and listening to the sound thus produced. Over undisturbed ground the sound is dull ('thud, thud'); over a filled-up ditch or pit it changes to a more resonant note ('thoomp, thoomp'). The sound is best observed by a helper stationed at a short distance and, when necessary, out of the wind. Systematic bosing of an area can be carried out, as with the probe, on a grid system, the points where a change of note is observed being marked with pegs. It is as well to check the accuracy of the work by a few tests with the probe.

A heavy pick-axe may be used as a boser, if the haft projects an inch or two beyond the head; a better instrument, however, can be made from a cylindrical cocoa tin filled with molten lead, in which is embedded a short length of iron pipe; this serves as a socket for a wooden broom-handle about 5 ft. long. The base of the instrument should be slightly convex.

The usefulness of bosing appears to be confined to chalk and other hard rocks, which are covered only by a thin layer of topsoil and a firm, close-cropped turf.

The second method is more elaborate, but in suitable circumstances enables buried structures to be detected with considerable accuracy where the use of the probe or auger is misleading or impossible; it is known as *resistivity surveying*, and has long been in use for large-scale site-investigation in civil engineering;

the only novelty of the method lies in its application to the small-scale problems of field archaeology.

It is well known that the earth is a conductor of electricity. Most of the minerals forming soils and rocks are not themselves good conductors, but depend for their conductive effect upon the water, containing mineral salts in solution, which permeates them all to a greater or less degree. The amount of moisture in a deposit depends largely upon the size of the particles composing it; earth, clay and loam hold more water, volume for volume, than do natural rocks such as chalk, limestone, sandstone and granite; and these in turn hold more than coarse and less compact materials such as gravel and rubble. These differences in moisture will give rise to differences in electrical conductivity, and therefore to differences of electrical resistance; and if the resistance can be measured with a suitable instrument, changes in it can be interpreted in terms of the buried structures which give rise to them.

The instrument used is the 'Megger' Earth Tester, manufactured by Messrs. Evershed and Vignoles. It consists of a wooden case which can be screwed on to the top of a small tripod. At one end is a handle which is rotated at about 130 revolutions per minute to generate the required current. On the top is a graduated dial over which a needle moves to indicate the measured value of the resistance, and a small spirit level by which the instrument is approximately levelled on its support. At the end opposite the handle are four terminals marked C1, C2, P1 and P2; the link which can be used to short-circuit two of these terminals should be kept *open*. The rest of the equipment comprises four electrodes of ½-inch mild steel bar, pointed at one end, and four 75 ft. lengths of rubber-covered single-core wire, each terminating at one end with a spade-terminal and at the other with a crocodile clip large enough to grip the electrodes. The equipment is shown in Plate X.

Readings of resistance are taken at equal intervals along a straight line marked by a measuring tape (a chain, being a conductor, should not be used). The electrodes, numbered 1 to 4, are thrust firmly into the ground at equal intervals along the tape; in hard ground it may be necessary to hammer them in.

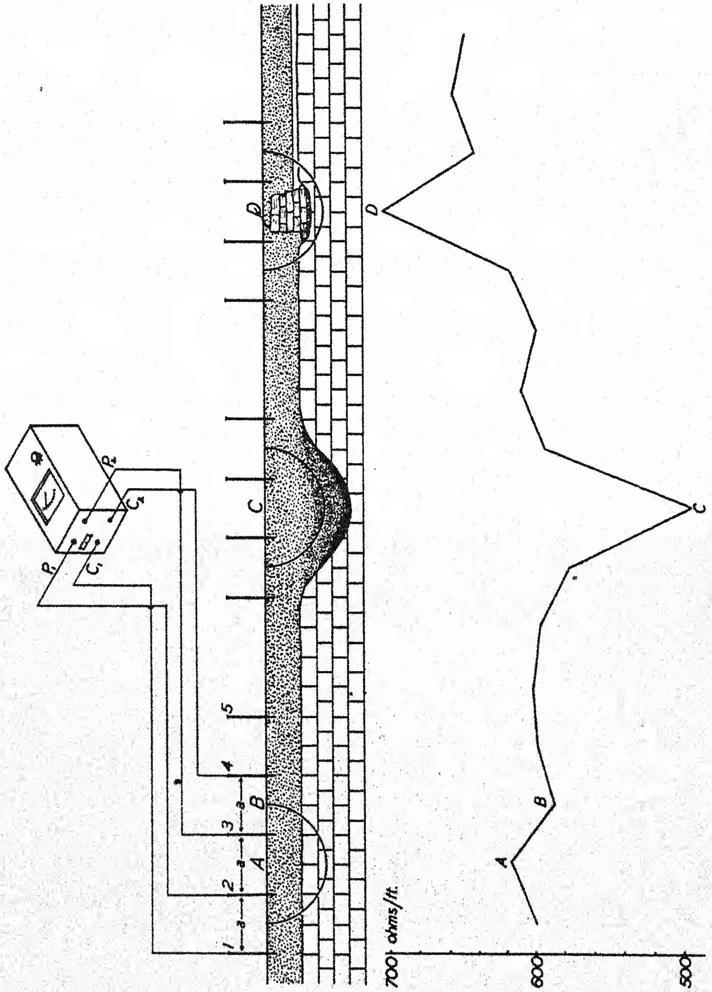


Fig. 1

They are connected by their insulated leads to the terminals on the instrument in the following order: 1 to C1, 2 to P1, 3 to P2, and 4 to C2.

The principle of the method is shown in Fig. 1. When the handle of the instrument is turned, a current is generated and passes by way of the terminals C1 and C2 and the electrodes 1 and 4 through the ground between the latter. A potential gradient, or difference of voltage, is created between electrodes 1 and 4, and therefore, in less degree, between electrodes 2 and 3. Part of the current therefore passes through the circuit containing these electrodes and terminals P1 and P2. The ratio of these two currents is measured by the instrument, and the reading on the dial is a measure of the resistance of a volume of ground, which is normally taken to be approximately a hemisphere of radius equal to the electrode separation (Fig. 1, x), centred on the mid-point of the electrode system (Fig. 1, A).

When the first reading has been taken the electrodes are moved along the tape by a distance equal to their separation. In practice it is necessary only to move No. 1 to position 5, and reconnect the leads by shifting the crocodile clips to the next electrode along the line. The second reading, which refers to the point B, is now taken; the end electrode (formerly No. 2) is now moved to position 6, and the leads again reconnected. In this way a series of readings is obtained at equal intervals all along the tape.

The readings are plotted in the form of a graph on squared paper. On undisturbed ground, where the measured volume includes a large proportion of highly-resistant subsoil, the resistance will be relatively high; over a filled-up pit or ditch containing soil of low resistance, the resistance will drop (Fig.1, C); and over a wall, floor, road-surface or patch of rubble material, it will rise to an even higher figure than on undisturbed ground. These changes are shown by a specimen curve in Fig. 1.

The accuracy with which the underlying changes of structure will be reflected by changes of resistance depends upon a careful choice of electrode separation. Generally speaking, the separation should be from 1½ to 3 times the depth of the topsoil on undisturbed ground, with a minimum separation of 3 ft. With

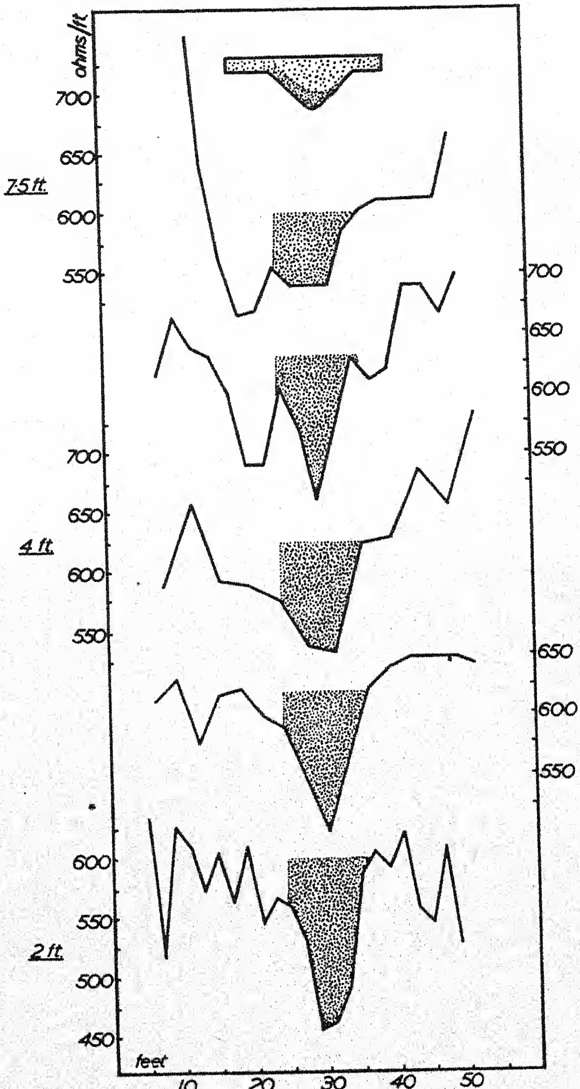

ohms/ft
700
650
7·5 ft.
600
550
700
650
5 ft.
600
550
700
650
4 ft.
600
550
650
600
3 ft.
550
600
550
2 ft.
500
450
feet
10
20
30
40
50

Fig. 2

separations greater than 5 ft. it may be desirable on each line of readings to interpolate a second series spaced evenly between the first, in order to obtain a smoother and more informative curve.

Similar structures will not always produce corresponding anomalies in the resistance curve on different subsoils. On gravel, sand, or clay, for instance, a ditch will generally appear as a depression in the curve; but on chalk or rock a similar ditch may give rise to a peak, if the measured volume includes a high proportion of rubble silting.

Fig. 2 shows a number of curves obtained on the same line across the same ditch with varying separations of the electrodes, and illustrates the importance of choosing the optimum separation. Fig. 3 shows the curve of resistance over two buried ditches

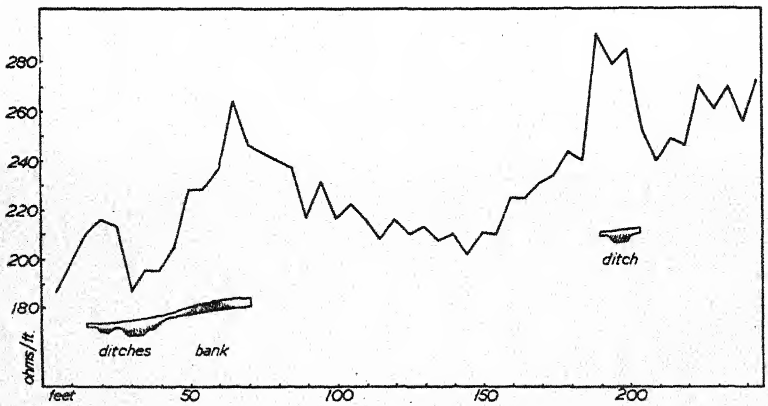


Fig. 3

on chalk, the larger appearing as a depression and the smaller as a peak.

The choice of lines on which to take readings (traverses) will vary according to the circumstances. For isolated linear features such as roads, ditches and walls, the traverses should pass approximately at right-angles over the suspected line of the structure. For circular ditches parallel traverses should be run across the suspected area, until one is obtained on which the

ditch appears at two points. This should be a chord of the circle, and a second traverse at right-angles to it through its mid-point will be a diameter of the circle, on which the mid-point between the two indications of the ditch should mark the centre; a third traverse at 45° to the second will provide a useful check.

For more complex sites parallel traverses should be run at intervals from each other equal to the electrode separation used, so that readings are obtained at regular intervals all over the site. 'Contours' joining points of equal resistance are then drawn,

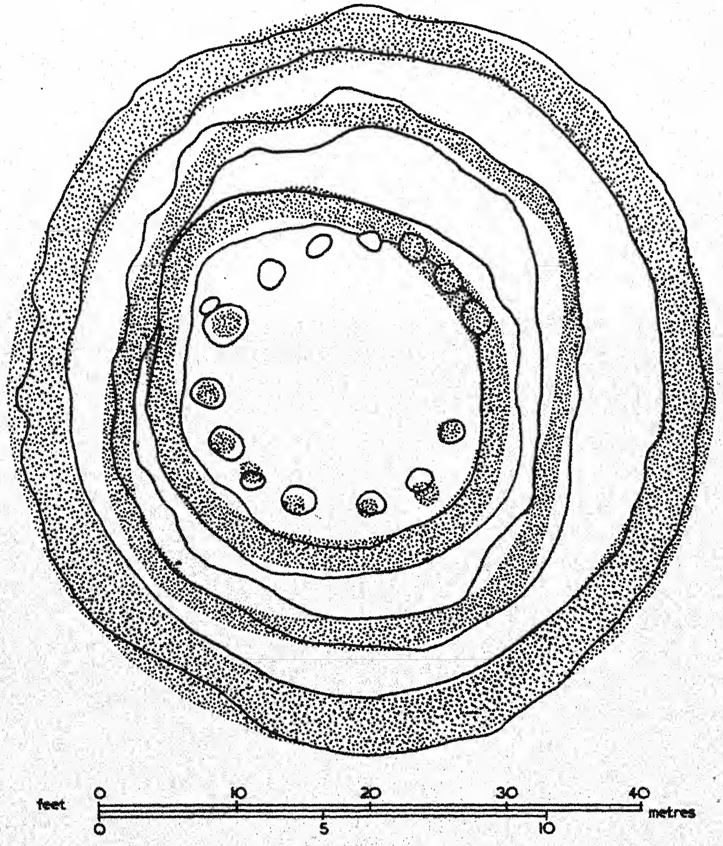


Fig. 4

exactly as in plotting contours of height (p. 118). From these contours the plan of the site can be interpreted, sometimes with great accuracy. Fig. 4. shows the result of such a contour-survey. The stippled areas represent the plan of ditches and pits deduced from the survey, based on 1200 readings; the continuous lines show the actual boundaries of these features as revealed by subsequent excavation.

Resistivity surveying requires at least two operators, one at the instrument and one to move the electrodes. The writer has devised a system of working which avoids halts for changing the electrodes and enables readings to be taken continously; details will be given to enquirers on request. This system enables readings to be obtained at the rate of 200 to 300 per hour, including the time taken to set out fresh traverses.

The resitivity method is not suitable for the detailed interpretation of complex occupation sites, and cannot be used satisfactorily where the topsoil is too shallow to hold the electrodes firmly. It has, however, proved to be of great value for the tracing of relatively simple, isolated structures, and for the accurate location of features before excavation, without the necessity of cutting trial-trenches.

The initial cost of the instrument is high (£50 to £80, according to type), but there are no maintenance costs. The manufacturers will hire out an instrument at 30s. per week; the hirer can make up his own electrodes and leads at a cost of about 30s.

It is convenient to mention here another electrical instrument that has proved useful in the field, namely the *mine-detector*. The instrument consists of a search-coil which is moved about over the ground, an amplifier-pack, and a pair of head-phones; the presence of metal close to the search-coil is indicated by a sound in the head-phones. Military patterns of detector, some of which can be obtained from Government Surplus dealers, vary in sensitivity; the most sensitive will detect a small coin at about 5 inches and a large one at 7 inches from the surface. The 'Cintel' Metal Detector, manufactured by Cinema Television, Ltd., for civilian use, has about the same range, and will detect a large metal object, such as a sword, at about 14 inches.

The chief use of such detectors is in the excavation of graves

and occupation-layers in which metal objects may be expected to occur. In such cases the soil is usually removed in a series of shallow layers, and the surface of each layer can be swept with the search-coil before it is dug away. The use of a detector in this way will prevent damage to delicate metal objects, since their approximate position will be known in advance. The detectors at present available are not sufficiently sensitive to indicate the position of, e.g., Saxon graves from the surface, unless they are very shallow or contain very large metal grave-goods.

Two other methods of detecting ancient habitation-sites have been developed on the Continent, but have not yet been used extensively in Britain. In the first, samples of soil are taken at intervals over the area of search, and determinations made of their phosphate-content. The neighbourhood of a former human settlement is likely to be marked by relatively high concentrations of phosphates, derived from animal and other refuse. The second method is an application of the technique of pollen-analysis of samples from peat-bogs. The presence in a sample of the pollens of cereal and other cultivated plants, or of the weeds that accompany and follow cultivation, indicates that a settlement must be located in the vicinity.

OBSERVATION

So far no mention has been made of that faculty which is, above all, necessary in field-work, namely, the faculty of critical observation. If this be lacking even the highest technical skill in surveying and other methods is of little value.

The field-worker must have, or, if he has it not already, must develop, an 'eye for country'. Just as a soldier sees a landscape in terms of military positions, and a civil engineer in terms of levels and gradients, so the field-worker must see his landscape as a series of possible or likely sites for ancient settlements, defences, and roads. Indeed, half the business of field-work consists not in looking for sites, but in knowing where to look for them.

No less important than an 'eye for country' is an 'eye for ground'; the ability, that is, to detect and interpret small differences in the surface relief of the ground. The student will

find that after he has made a careful contoured plan of any piece of ground many slight, but often important, irregularities of the surface can easily be picked out on re-examining the site, although without the aid of the plan they would not have been seen. With constant practice it should be possible to distinguish such slight irregularities by eye alone, without invoking the aid of instruments.

In many ways field-work resembles detective-work. Both involve a great deal of hard routine which may often seem fruitless; both consist of the careful collection of small facts which must be fitted together to make a coherent chain of evidence. Needless to say, no opportunity of picking up clues should ever be neglected; no commercial excavation of any kind (quarry, gravel-pit, sewer- or foundation-trenches), no rabbit-scrape or mole-heap should be passed without examination for possible archaeological traces.

How to search for and record traces of ancient monuments in the field can only be learnt by practice, with the help of constant observation of known monuments in all stages of decay and obliteration. The field-worker must be familiar not only with the appearance of ruined *ancient* structures, but also with more recent traces of human activity; he must be able to identify a field bank from which the hedge has been grubbed up, a ruined field-wall or sheep-stell, or the overgrown foundations of a cottage or croft; and he must be able to distinguish these from basically similar structures of earlier date.

It is only upon marginal land that monuments survive more or less intact; in cultivated areas they are generally damaged, and are often ploughed quite flat, so that they are traceable only by faint and isolated indications. In such country attention should always be directed to the field-boundaries, where the profile of earthworks is often preserved beneath the hedge or wall, though invisible elsewhere. Even where the actual profile is not preserved, sudden kinks or changes in direction of a field-boundary may show where a buried ditch or road passes beneath it.

In tracing earthworks of very slight relief, the direction of the light may materially affect their visibility. When the ground

is covered by long grass or rough vegetation, it is preferable to look with the sun at one's back; from the opposite direction the shadows cast by plants and other minor irregularities tend to distract the eye and increase the difficulty of appreciating the relief.

Finally, the field-worker should remember that much of his work will take him over land belonging to others. It is only courteous to ask permission from the owner to walk and work over his land, and to respect the ordinary decencies of country life. Gates left open, hedges broken, or hay and crops trampled down will do little to popularize either the archaeologist or his science.

II. EXCAVATION

PRELIMINARIES

WHEN it is decided to excavate a site, certain preliminaries are necessary. The first of these is to obtain permission to dig, *in writing*, from the owner of the ground or his agent, and from the tenant or any other person whose interests are concerned. The reason for the proposed excavation should be stated, and an undertaking given to fence off the trenches, if necessary, e.g. to protect cattle.

A search should be made through local records for any previous mention of the site, or of archaeological finds made in the vicinity; local people should also be asked for any relevant information.

The site should be carefully examined on the ground, and a large-scale map made of the area to be excavated, including any surface features visible and any prominent fixed landmarks. This map will subsequently serve as a basis for a trench-plan, and as a key to the system of reference points necessary for recording (*v. infra*, p. 143).

If any air-photographs of the site exist they should be studied with the greatest care, and an attempt made to identify any marks on them with features on the ground. If the site lies on a shallow topsoil this may be done by probing or 'bosing', any discoveries thus made being marked on the plan.

Two or more small test holes should be dug a short way outside the area to be excavated, in order to ascertain the nature of the natural rock and its depth below the surface. A single test hole is insufficient, as in many places, notably in oolitic limestone country, the natural rock may vary very considerably even within a small area.

Finally, the nearest inn should be visited. This is no mere concession to the intending excavator's thirst. The local inn is the best place to meet and get to know the local people, whose special knowledge may be very valuable. It is also the place to find out from whom ladders, planks, and other suddenly needed equipment may be borrowed or hired.

EQUIPMENT

The list of equipment which follows is designed to cover the majority of problems likely to be encountered during an excavation. It is improbable, however, that all of it would be needed on any one site.

On all excavations, and in particular where work is being done at some distance from the nearest house, it is of great advantage to have a *small hut* on the site. This hut is used for storing tools, equipment, and finds, for making drawings and records out of the wind, and for shelter at meal-times and during rain. A portable hut, which can be transported flat and bolted together on the spot, is the most convenient type; it should measure not less than 6 by 9 feet, and have at least one window and a strong lock on the door. Inside, a sloping drawing-table should be fitted beneath the window, to fold back flat against the wall when not in use, while folding shelves on one wall will provide useful space for storage of finds during the work.

Wheelbarrows are essential where earth is to be dumped away from the cuttings. The most convenient type is of metal with a pneumatic rubber tyre; the handles should be fitted with special rubber grips, or bound with strips of sacking, as the bare metal is unpleasant to touch in cold weather.

Where students or volunteers are employed, it is better to provide the small light metal wheelbarrows sold for use in gardens. Many volunteers, particularly women, cannot be expected to handle full-sized barrows with a full load.

Planks will be necessary to make run-ways for pushing the wheelbarrows, and for shoring up the sides of deep cuttings in loose soil. The ends should be bound with strips of sheet-metal to prevent splitting and splintering.

Buckets will be needed for carrying excavated earth when digging at a distance from the dump or wheelbarrow, and for baling out waterlogged pits and ditches.

For excavating wells and other very deep cuttings, a *windlass*, *sheer-legs*, and a *large bucket* will be required.

Marking-pegs for setting out trenches and reference points

should be of wood, not less than $1\frac{1}{2}$ inches square, about 18 inches long. Metal *meat-skewers* are useful for fastening marking-strings and datum-lines.

On sites where the rock is close to the surface, wooden pegs cannot be driven in, and should be replaced with $\frac{1}{2}$-inch steel pegs, round or square in section, about 9 inches long.

Cord used for marking out trenches and for datum-lines should be of the strong but elastic variety known as 'builder's line'. When not in use it should be rolled neatly on to a metal peg to prevent tangling.

For photography, a *long ladder* and *two scaffolding-poles*, or *two plasterer's ladders* and *a plank*, are needed to make a platform (p. 157).

For recording, the excavator requires a set of *wooden trays* or *large metal tins*, *stout glazed brown paper bags* in various sizes, an assortment of *cardboard boxes* and *tins* with lids (tobacco tins are very suitable), *stick-on*, *tie-on*, and *price-tag labels*, and *Indian ink*.

EXCAVATING TOOLS

An excavator's ability can be measured by the way he chooses, uses, and cares for his tools. Needless to say, it is false economy to buy cheap tools; only the best and most solidly made should be used.

The large tools (i.e. the spade, pick, fork, and shovel) are made in a number of sizes; the occasional excavator will probably find that he can work more quickly with one of the smaller but lighter sizes than with the full-sized tools used by the professional navvy.

The blades of new tools should be polished bright all over with a wire brush and abrasive, which will make them easier to use, and will prevent earth sticking to them. All tools should be scraped clean frequently with a trowel during use, and at the end of each day's work. When they are stored out of use they should be oiled or greased to prevent rusting.

Every tool should be branded (*not* painted) with the owner's initials on the wooden handle to discourage theft. Spades, forks, and shovels which cannot be locked up at night during

the work should be threaded on a stout chain through their handles and padlocked together; they can then be buried in a dump on the site.

Shovels and spades are made with both 'T' and 'D' handles. The present writer finds the latter pattern more comfortable in use, and it has the additional advantage that it can be padlocked up for security. This is, however, a matter of taste in which each excavator must suit himself.

Turf-cutters and Lifters. Except where the turf is good and must be replaced after the excavation, it is a waste of time to use these tools to cut turf into the 'swiss rolls' beloved by gardeners. For all normal purposes the spade is a far quicker tool to use. The crescentic-bladed turf-cutter is, however, a useful tool for smoothing the sides of sections cut in clay or fine soil.

Spades. The spade is often held to be the symbol of excavation, but in practice it is only rarely employed. Its main uses are cutting and lifting turf, trimming the sides of sections to a vertical plane, and scraping down horizontal surfaces in a series of thin shavings. For these purposes the edge of the spade should be kept sharp on a grindstone. The most convenient type of spade is one which has an almost straight cutting edge, and a small flange fitted to the upper edge of the blade, on which the sole of the boot can be pressed.

A spade should never be used for shovelling. It will hold very little earth, and the handle is at quite the wrong angle to the blade for comfortable use in this way.

Forks. The fork is the chief tool for routine digging in loose and fine-grained deposits; it cannot be used satisfactorily on clay or rubble. The prongs should be gently worked, not jabbed, into the ground, and the soil levered up in front and broken up finely; in this way there is least risk of damaging finds. It will be found that with practice the fork can be used as a delicate probe for detecting slight differences in the texture of underlying layers.

The prongs of the fork should be round or square in section, and should be kept sharp; potato-forks, with flat ribbon-shaped

prongs, are less suitable, though they are occasionally useful for the rapid removal of sterile layers which need not be broken up.

Shovels. For use in fine soils the shovel should have a rectangular blade, flat except at the lateral edges. For work in rubble and on rock the heart-shaped pattern is essential.

The secret of rapid easy shovelling is rhythm. The earth-laden shovel should never be lifted; instead, the movements of filling and emptying should be made with a swinging motion, each forward swing being balanced by another backwards. With practice the digger should be able to throw a shovel-load of earth accurately on to a given spot up to 6 yards away, without undue effort.

Picks. The pick is the tool for routine digging in very hard stony soils, rubble, clay, and on rock. It should be swung lightly and easily, and drawn towards the digger as it enters the ground; in this way the material is broken up with the least destruction of finds. In very coarse rubble deposits the pick must be used as a lever to loosen individual stones, which are then picked out by hand.

Work with the pick should always start close to the digger's feet and proceed away from him, so that the working-face is visible all the time. In fine-grained material it should be possible to cut a vertical face with the pick up to 9 inches deep almost as neatly as with a spade.

In clay the pick is used to detach large lumps from the working face, which are then broken up by hand or with a trowel.

The ordinary pick has one tine pointed and the other terminating in a transverse cutting edge about 1½ inches wide. This edge should be kept sharp, and is especially useful for cutting through small roots. For really large roots a grub-axe is needed. This resembles a heavy pick with the pointed tine replaced by a miniature axe-edge parallel to the line of the haft.

A small light tool, somewhat cynically known as the 'gentleman's pick', is useful in confined spaces and for very delicate work.

The side of the pick-head, where it encloses the haft, may be used, in the absence of a mallet, for driving in wooden pegs.

The head of the haft may also be used instead of the special instrument already described for 'bosing' (p. 31).

Crowbars. For loosening and removing large boulders crowbars will be necessary; they should be not less than five feet long. To remove boulders to a distance a plank runway must be laid to the nearest practicable point, and a full-sized wheelbarrow placed in position on its side, facing the boulder. The latter is then gradually levered as far into the barrow as possible, and the barrow then pulled upright, bringing the boulder up in it. When handling heavy stones great care must be taken to avoid trapping the hands or feet by careless or violent movements. Work of this kind should not be left to inexperienced people.

Hand-shovels. Small hand-shovels are used for working in confined spaces, where there is no room for the full-sized tool. One very useful type has a blade about the size and shape of the full-sized instrument, fitted with a short wooden handle; another is the ordinary all-metal coal-shovel with a blade about 4½ inches wide.

Trowels. The mason's 5-inch pointing-trowel is the chief tool used by the excavator for delicate and careful work. The blade must be quite flat, springy, and almost parallel with the handle; the tang must be cast in one piece with the blade, and should not be rivetted or welded to it; the point should be slightly rounded to prevent damage to finds. A more comfortable and durable trowel can be made by cutting down the blade of a 10-inch bricklayer's trowel (annealing it first and re-tempering it afterwards) and fixing it in the wooden handle of a gardener's trowel. The latter has a rounded end which is less apt to blister the palm of the hand than the pattern usually found on a pointing-trowel.

The trowel is chiefly used in four ways. In the first the point is pushed into the ground downwards and forwards, and the earth loosened by a slight twist and flick of the wrist; in the second, where it is desired to dig an area in a series of shallow layers, the trowel is held pointing to the left, with the back of the hand upwards and the thumb towards the digger; the earth is removed from a face about 2 inches deep and scraped away to the left. In the third method, the trowel is held in the same way, but is drawn towards the digger with a scraping motion,

the lower edge only touching the earth; while the fourth method, used only for the most delicate work of all, requires the trowel to be held vertically, point downwards, from which position it is tapped quickly and very lightly up and down to loosen the earth, which is then blown away (Plate VII).

The ordinary curved gardener's trowel is useful only for excavating post-holes or small pits where even a small hand-shovel cannot be introduced to remove the loosened earth. For very narrow post-holes there is an excellent gardener's tool which resembles a large apple-corer.

In place of the mason's trowel some workers prefer to use a blunt glazier's knife. This tool has the disadvantage that its handle is in the same line as the blade, so that it cannot be used effectively as a scraper.

Brushes. The use of the brush in excavation should never be neglected. Only too often a discovery is missed or improperly understood because all the loose earth has not been brushed away. It is an excellent rule always to use the trowel and the brush together.

For cleaning large areas, such as floors and the flat bottoms of trenches, a large stable-brush should be used. For work in confined spaces, for cleaning up masonry, and for use generally in conjunction with the trowel, a small *stiff-bristled* stair-brush is the best tool. For really delicate work such as the cleaning of skeletons and grave-goods *in situ*, a soft paint-brush should be used.

To be efficient a hand-brush should be used with short sharp strokes; slow brushing will always leave behind a thin spatter of earth and dust. Needless to say, a brush should never be used on damp earth, as it will only spread over everything a thin layer of mud. Brushing should be stopped as soon as the ends of the bristles begin to become clogged with little balls of wet earth, and the latter should be scraped off before they harden.

Spoons. Long-handled spoons, or soup ladles, are very useful for clearing out the bottoms of deep, narrow holes which cannot be reached by the hand.

Probes. The use of the probe has already been described

(p. 29). The best instrument consists of a sharp-pointed steel rod, ½ inch in diameter and about 40 inches long. To the upper end is fixed a stout wooden 'T' handle, which is secured so that it cannot turn on the rod or slip down.

In use the probe is inserted about one foot into the ground and pushed round and round to enlarge the hole slightly. It is then driven downwards by a series of strong thrusts, which must be delivered with the user's full weight. A little practice enables the difference between casual obstruction and bed-rock to be readily detected.

Other tools. Apart from the more common ones already mentioned there are a few other tools which may from time to time be needed. A *pair of bellows* can be used to blow away loose earth from finds which are too fragile to be brushed; while for loosening the earth under such circumstances the excavator may need a *pen-knife*, a *bodkin*, or even a *darning-needle*. A *garden syringe* may be required for wetting sections or floors before photographing them, and for keeping damp delicate finds which must not be allowed to dry and warp. A fairly coarse-meshed *sieve* may sometimes be needed to search for coins, beads, and other small objects, but its use should not be encouraged, as the exact original position of finds made in this way cannot be determined.

TRENCH SYSTEMS

The three main objects of the excavator are these: to uncover the plan of structures in the horizontal plane; to ascertain the sequence of stratified layers in the vertical plane; and to establish the relations one to another of the finds contained in those layers. In planning his system of trenches, therefore, the excavator must bear these aims in mind; he must also consider the nature and surface appearance of his site, and the time and labour at his disposal.

Where the existence and position of archaeological features is already known, the task of siting trenches is comparatively easy. It is, however, a matter which must be learnt by experience, and upon which little guidance can be given here. There is no standard method of excavating such a site; each problem

must be considered on its own merits. The one guiding principle is this, that the excavator must understand clearly exactly what questions he wishes to answer, and so plan the work that those questions may be answered with the greatest economy of time and labour, and, if possible, in the most logical order.

On the other hand, where the position of archaeological features is not clearly defined, some systematic method of searching the ground by trial trenches is required. Four such methods are described below.

The grid system. The site is first divided into squares whose corners are marked by reference pegs (Fig. 5). The squares may have sides 25, 50, or even 100 feet in length, according to the size of the area to be searched, the type of discovery expected, and the time and labour available. Trenches are then laid out with their outer edges 1 foot inside the lines of the reference grid, on the north and east sides only of each square (Fig. 6). The trenches should be separate, with baulks at least 3 feet wide between them.

The interrupted grid system. This system is substantially the same as the last except that the continuous trenches are replaced by lines of pits, each, say, 6 feet by 3 feet, separated by baulks 3 feet wide (Fig. 7). This method enables a much larger area to be searched in a given time, provided that the depth of soil is not greater than about 40 inches. Where necessary, the intervening baulks can easily be dug away to give a continuous line of section.

The point system. A fairly close grid of pegs is laid out to divide the site into squares. On one side of each peg a small pit is dug, say, 6 by 3 feet, or 4 feet square (Fig. 8). This method is suitable only when a large and comparatively barren area has to be searched rapidly. The risk of missing structures is, of course, great, unless the pits are very close together. A useful interval is 20 feet, but this must be varied according to the circumstances.

The box system (Plate V, *a*). This method, a development of the last, is used to clear an area down to the natural rock. As before, the site is divided into squares by a grid of reference points; the sides of the squares should be from 15 to 25 feet

long. Within each square a square cutting is laid out, its sides being normally not less than 18 inches from the line of the reference grid. This will give a series of box-shaped cuttings separated by 3-foot baulks, which will provide vertical sections

Fig. 5

Fig. 6

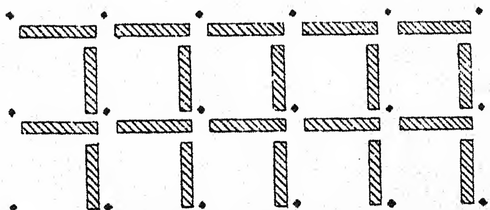


Fig.7

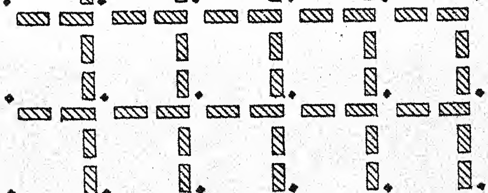


Fig.8

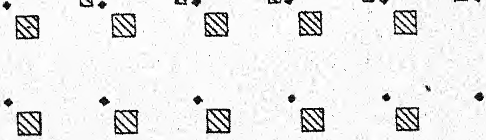
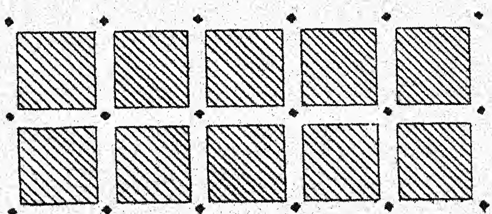


Fig. 9



and are wide enough to accommodate a wheelbarrow. If the earth is to be shifted in buckets to a wheelbarrow or dump outside the cleared area, the widths of the baulks may be reduced to 24 or even 18 inches (Fig. 9).

Once the 'boxes' have been excavated down to the natural rock and the necessary sections have been drawn, the baulks may be dug away, leaving only the reference pegs isolated on small blocks of unexcavated soil.

On the whole, small 'boxes' about 12 feet square are to be preferred to a larger size; in a small 'box' the excavated earth can be shovelled direct into wheelbarrows standing on the baulks, while in a larger one buckets must be used, which slows down the rate of progress.

Two other systems of cuttings are sometimes used. The first consists of a series of parallel trenches close together, the earth from one being dumped into another already dug immediately behind it. This system has nothing to recommend it, as only a very narrow strip of the site is exposed at one time.

The second method is a development of the last. A series of broad parallel strips are laid out, running the whole width of the site. Alternate strips are first excavated, the earth being dumped temporarily on the intervening unexcavated spaces. When this stage of the work is complete the earth is moved back and the process repeated with the remaining strips. This method is useful only when the topsoil is very shallow; even then it requires a labour force beyond the scope of the kind of operation envisaged in this book.

LAYING OUT TRENCHES: TURF AND SOIL DUMPS

It should be a golden rule never to cut a trench without first marking it out with pegs and string. The sides of the trench must be parallel, and the corners right-angles. If wooden pegs are used they should be placed so as to lie outside the area of the trench (Fig. 10).

The turf should be removed in blocks about 15 inches square with a sharp spade; the cuts between the sods should be vertical, especially at the edges of the trench, where the spade should be held upright touching the inside of the marking-string. If

the grass is long it should be cut with a sickle or scythe before removing the turf.

On many sites in the highland zone the surface vegetation consists of moorland grass or heather, growing almost directly upon the natural rock, and separated from it only by a layer of matted rootlets. Here the edges of the trench must first be cut with a really sharp spade, which is thrust downwards, cornerwise, with considerable force; it will be necessary frequently to resharpen the spade with a coarse file or a carborundum whetstone. The area within the edge of the trench is then divided into lengthwise strips about 10 ft. long and 18 ins. wide. The turf at the upper edge of the strip is first eased up by thrusting the spade beneath it; this loosened edge is then grasped by an assistant and pulled upwards and backwards, while the spademan cuts through the rootlets thus exposed. In this way the whole strip may be torn off in one piece; it is then rolled up and stacked neatly by the side of the trench.

If the earth is to be dumped by the trench, the turf should be stacked neatly in a low wall about 18 inches from the edge of the trench, behind any reference pegs, to act as a retaining wall for the dump; otherwise, it should be stacked neatly at a distance. During the summer the turf-dumps should be watered from time to time to keep the grass alive.

Under no circumstances should turf be hacked up with a fork or pick, nor should it ever be mixed indiscriminately with excavated soil (Plate V, *b*). The excavator should always aim at leaving his site as nearly as possible in the same condition as he found it, and this can only be achieved by neat and orderly arrangement of the dumps.

The excavated earth may either be dumped by the side of the trench by shovelling alone, or it may be carried away to a more distant dump in wheelbarrows. In the former case the dump should be placed whenever possible on the far side of the trench from the prevailing wind, i.e. usually on the north or east sides. The building of dumps is a skilled business, and needs more attention than is often given to it. For economy of effort dumps should be as high as possible, and as near as possible to the source of the material being dumped. The

initial stages of building a small high dump, with a ramp leading to the top, require constant supervision. Once this is built the material is dumped from the top down the far slope, and the dump is thus extended *away* from the site. By the addition of successive layers, and by lengthening the approach-ramp, so that its slope remains constant, the dump can eventually be built to a height of six to ten feet. At all costs, low, wide-spreading dumps should be avoided, as they greatly increase the distance to be travelled with fully-loaded wheelbarrows.

Dumps of stone and rubble require more care in their construction than do those of earth, especially if the site is to be preserved in its excavated form, so that the dumps become a permanent feature. In this case, it will be necessary to use the larger stones to form stout revetting-walls round the outer margins, the central core being filled with the finer rubble.

Needless to say the sites for dumps must be carefully chosen, and should if necessary be searched beforehand with a probe, by a resistivity survey, or other means, to ensure that the dump is not placed on top of features which may subsequently have to be excavated.

Dumping beside the trench is quick and requires no extra labour, but there is always the risk of having to extend a trench sideways and shift the dump, which is a tedious business. The alternative of dumping at a distance avoids this difficulty, and adds undeniably to the neat appearance of the site; and it is essential wherever a large area has to be completely stripped. Much time and labour, however, are consumed in carting the earth to the dump and back again for filling in the trenches. Which of these two methods is to be adopted on a site can only be decided on consideration of the time and labour available and the likelihood of having to enlarge the trenches.

Walking and standing on the dumps should be discouraged, as it dislodges earth into the cuttings, and packs the dumps so that they are difficult to shift.

The width at which trenches should be dug requires careful consideration, in order to avoid danger to the excavator and the extra labour of having to widen them. Normally no trench should be less than 3 feet wide; those likely to go deeper than

4 feet 6 inches should be 4 feet wide; and for trenches estimated to be deeper still the width should be increased so that it is never less than half the depth.

Up to 5 feet deep trenches can be dug with vertical sides; below this depth the sides should have a batter (i.e. an inward slope) of at least 1 in 8. This batter should be increased when digging in loose material such as sand, where the sides even of shallow trenches will fall in if they are cut vertically. Needless to say, a dump should never be placed on the edge of a deep trench or one cut in loose soil; to do this is to court disaster.

THE TECHNIQUE OF EXCAVATION

In a nation of gardeners digging up the ground is so much an everyday thing that it is easy to imagine that any one can do it well. Excavation, however, like any other job, has its special technique, which can only be learnt with practice. The following few points are given as an aid to acquiring an efficient style of digging.

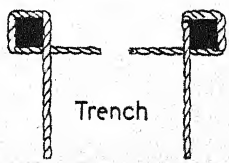


Fig. 10

Always dig in spits (i.e. the depth of the prongs of a fork, about 9 inches) of equal depth along a trench, unless this will encroach on the next layer below.

In each spit dig out the ends of the trench first for a distance of about 2 feet, and shovel out the loose earth, before starting on the middle portion. This enables the excavator always to have a piece of clear ground to stand on.

Always dig *one layer only* at a time; failure to do this entirely destroys the accuracy of the system of recording (*v. infra*, p. 138).

Cut sharp right-angled corners at the sides and bottom of the trench as the work proceeds. Do not leave this trimming up until the trench is finished.

Keep the sides of trenches vertical (except, of course, when a batter is needed, as already explained). This can only be done by getting the fork or pick right in against the side of the trench at each spit dug. To allow the sides gradually to creep inwards, and then to shave them down to a vertical plane with

a spade, is thoroughly untidy, and indeed unscientific, as it may confuse the recording of finds thus displaced.

Never under-cut the side of a cutting in order to bring down the overlying earth. Never tunnel into the side of a trench except to remove objects which project so much as to cause an obstruction.

Always use a trowel and brush when anything unusual is encountered. Clear up with the trowel the last traces of one layer before starting to dig into the next one.

Never use a heavier tool than a trowel to dig any layer in which important finds are likely to be made. Never, for instance, dig a grave with a fork, however far you think you may be above the skeleton and grave-goods.

The excavator digs 'blind'; he cannot see what lies beneath him. He can, however, with practice, learn a great deal simply by feeling the ground delicately with the fork. This is a habit which should be cultivated, for it may often provide a timely warning of the presence of some unsuspected layer or object, and so prevent a serious mistake. For instance, the clay filling of a pit dug in the same material may, to the eye, be indistinguishable from the surrounding undisturbed ground; the limits of the pit can only be found by the feel of the soil, for, however long the filling has been there, it will never be quite so tightly packed as soil which has never been disturbed.

The task of distinguishing between natural (i.e. undisturbed) and artificial layers is made easier by the phenomenon popularly known as 'dried peas'. These are small round pieces of grit, which tend to collect on the line of junction of the natural rock with the layers lying over it. They occur on rock, chalk, and gravel formations, and sometimes on sand. On clay the presence of 'dried peas' is rare, but its place as an indicator is taken by matted grass roots, which are often found growing downwards between the sides of a pit and its filling.

Excavation in the highland zone requires its own special techniques. Rocky subsoil and dry-stone structures cannot, naturally, be excavated as neatly as fine soil deposits, and smooth vertical sections and level floors are impossible to achieve. Nevertheless, it must be stressed that the same general

principles apply. On many sites in the highland zone stone-built structures survive in good preservation to a fair height. In many cases the attention of the excavators has been directed exclusively to the surviving parts of the original structure, and the rubble which fills and surrounds them has been summarily removed with no regard for its evidential value; in consequence the interpretation of the site has been undertaken only at a stage when much necessary evidence has been destroyed. It must be emphasised that the excavator must study his site as a whole; the products of the *decay* of structures are as important as the surviving parts of the structures themselves. This point has longer been appreciated on earthwork sites of the lowland zone, where the distinction between original and derived deposits is often obscure. It is essential that it should be appreciated equally in the highland zone, where the distinction is easier to make, and there is in consequence a temptation to concentrate solely upon the clearing of the original structures.

MECHANICAL EXCAVATORS

For normal archaeological work the mechanical excavator is not suitable, since it takes no account of the minutiae with which the archaeologist is concerned. It may often happen, however, that excavations are being carried out for rescue purposes on a quarry or building-site where a mechanical digger is already in use; if this can be hired, even for half a day or less, to take off all but the last few inches of topsoil, the time and labour saved will amply compensate for any risk of damaging or losing finds.

As successful examples of the use of a mechanical digger under such circumstances, the excavation of the Holdenhurst Long Barrow[1] and the Bronze Age barrow and Anglo-Saxon cemetery at Stanton Harcourt,[2] Oxon, may be cited. At the former site sections were cut mechanically and cleaned up by hand; at the latter the machine cut the first trial section, and later removed the entire body of the barrow down to the natural gravel, to reveal the cemetery which lay round its periphery.

[1] *Proceedings of the Prehistoric Society*, III (1937), 1.
[2] *Oxoniensia*, x (1945), 23.

The present writer has also successfully employed mechanical excavators on a number of sites in the Oxford region.

For cutting individual trenches the best machines are the skimmer and the face-shovel; the depth of excavation can be controlled within fine limits, and the soil can be dumped on the ground up to 10 ft. from the trench, or in lorries. A drag-line excavator may also be used in soft soils only, but is not so accurate or so neat.

For stripping a foot or more of topsoil from areas of limited size any of the above machines can be used; if the shorter diameter of the site exceeds twice the throw of the machine, or if dumps cannot be made on its immediate margins, lorries must be used to remove the excavated soil.

For stripping large areas a bulldozer or grader is to be preferred, provided that dumps can be made on the edge of the area. In skilled hands these machines can shave off very thin layers successively over wide areas, leaving them flat, smooth and unencumbered by loose soil. The grader, being mounted on rubber tyres, does less damage to the surface than the steel-tracked bulldozer.

The cost of employing such machines is high, but is far less than that of doing the same work manually.

SOME SOILS AND SUBSOILS

The excavator will encounter many different types of soil and subsoil, each of which requires different treatment and adaptations of technique.

Chalk is probably the ideal subsoil from the archaeologist's point of view. It is hard, retains indefinitely the form of pits, ditches, and post-holes dug in it, and usually lies only a short distance beneath the surface. In some areas it may be covered by a layer of clay-with-flints, or heavily weathered flint nodules.

Natural undisturbed chalk breaks up upon excavation into small flat rectangular blocks, along parallel horizontal lines of cleavage. Near the surface it is usually somewhat friable and decomposed, with irregular brown-stained lines of cleavage. 'Dried peas' are often found on the undisturbed surface.

Exposed chalk is easily disintegrated by weathering and frost;

the filling of chalk-cut ditches and pits therefore consists largely of small chalk rubble and chalky earth, while near the bottom rainwash, greyish and powdery, may also be encountered. Chalk rubble produced by excavation of the natural chalk may usually be distinguished from naturally weathered silting by its larger size and the absence of admixed earth.

Puddled chalk, formed by wetting broken chalk and mixing it to the consistency of clay, is frequently used for floors. It is easily distinguishable by its broken and irregular texture on the one hand from the natural material, with its sharp lines of cleavage, and on the other from rainwash, which is more powdery and homogeneous.

Chalk forms an alkaline soil, which preserves well objects of bone, metal, shale, and jet.

One warning is necessary. Near the surface chalk is friable and decomposed; great care must be taken in excavation not to scrape away this soft but undisturbed material, and so manufacture structures which did not previously exist.

Limestone. Limestone shares with chalk the advantage of preserving the shape of pits and ditches cut in it. Certain types of oolitic limestone exhibit regular lines of cleavage, and, like chalk, tend to disintegrate on the surface.

On many limestone formations the surface of the rock is very irregular, with frequent natural pockets of clay and sand, which are often difficult to distinguish from artificial structures.

Clay. Clay is one of the most difficult materials in which to excavate. It is best dug with a pick or mattock, the detached lumps being broken up with the hand or trowel. In clay structures the component layers are seldom distinct, and any differences seen will be of colour rather than of texture. It is frequently difficult to tell when the undisturbed natural level has been reached, and deep test holes may have to be dug to settle this point.

Sections dug in clay should be drawn and photographed as soon as possible after exposure; once they become dry the surface will crack and flake, and will lose its contrasts of colour, so that the details of stratification are obscured. Where necessary a dry section can be improved for photography by shaving off the outer surface with a very sharp spade or turf-cutter.

It is often difficult to distinguish between the filling of a pit and the undisturbed clay in which it is dug, but the growth of roots along the surface of division may sometimes be helpful.

Gravel. Gravel is another very variable type of subsoil. It may be bedded uniformly and horizontally, with a flat even surface beneath the topsoil; or it may be contorted and contain boulders or rafts of rock and sand, with a surface pitted with pockets of clay and loam. These pockets are often large enough to affect the growth of overlying crops, and so produce on an air-photograph the appearance of a group of pits. Upon excavation, however, they are usually distinguishable from artificial pits by their irregular shape and sterile filling. The growth of roots into gravel will also produce earth-filled pockets, but these are usually recognizable as of purely natural formation by their tapering, funnel-shaped section.

Gravel is a loose material, easily disintegrated by weathering; ditches and pits cut in it quickly lose their shape if allowed to remain open, and their filling will contain a large proportion of silted gravel.

On exposure to the weather gravel tends to bleach slightly; the filling of pits and ditches which has been thrown back soon after excavation can therefore be distinguished by its lighter tone.

Gravel often undergoes changes due to the action of mineral-laden surface water. It may be stained dark brown by iron and cemented into masses of ferruginous conglomerate, or it may be solidified into patches of white calcareous rock by the deposition of lime. Neither of these formations is necessarily of ancient origin, and neither should be taken as a sign that the gravel thus solidified is undisturbed. A Bronze Age cremation recently observed by the writer lay upon the inside slope of the ditch of a round barrow; the gravel silting covering it had been bound together into a solid mass by lime, which must have been deposited later than the cremation. In another case the top six inches of the filling of a Middle Bronze Age grave-pit had been conglomerated by iron and remained after excavation partly projecting over the edge of the pit.

The surface of gravel is sometimes covered by a hard cal-

careous deposit known as 'callas'. This appears to be of ancient origin, and its discovery may be taken as a sign that the natural undisturbed rock has been reached.

Rock. So many varieties of natural rock are encountered in excavation that little can be said here concerning individual types. In some cases the rock surface may be compact and smooth; in others the uppermost foot or more may be heavily weathered to a fine crumbly texture, which renders very difficult the detection and isolation of small pits and post-holes. Rock-cut post-holes are often of irregular shape, depending upon the direction of the natural lines of cleavage of the rock, and in many cases can only be found by careful prodding of the surface with a skewer or surveyor's arrow, which will penetrate the softer earthy core surrounded by the packing-stones.

Sand. Sand is a very easy soil to dig, but is one which has several grave disadvantages for the excavator. Chief among these is its instability, which makes it necessary to dig trenches rapidly and to draw sections at once, before the sides fall in.

Deep trenches in sand must be cut with at least one side formed in a series of steps, each approximately 30 ins. wide and deep. The excavated material is shovelled up from one step to the next, and should be dumped well away from the upper edge. In very deep cuttings timbering may be necessary to support the sides. This work should be done by a qualified person; ill-designed timbering is more dangerous than none at all.

The second great disadvantage of sand is its destructive action upon organic matter of all kinds, and even upon metals. Bone and wood rarely survive except as stains, the soil retaining the form of objects as differences in colour.

This latter fact has had an important influence on the technique of excavating sandy sites. Since the objects and features often appear only as colour differences in an otherwise homogeneous soil, the normal method of uncovering loose finds and of removing the filling of ditches and pits cannot be employed. Instead the sand is removed from the site in a series of horizontal layers, so that the form and position of perished objects and structures can be recovered from plans made at close vertical intervals. This method has been de-

veloped with conspicuous success on the sandy plains of Holland[1] and North Germany, but it has hitherto only rarely been employed in this country.

SOME EXCAVATION PROBLEMS

Banks. Banks may vary in size from the 15- or 20-foot high rampart of a hill-fort to the barely perceptible enclosure-bank of an ancient field. In all cases, however, the procedure is the same. A section should be laid out at right angles to the line of the bank, long enough to extend some feet beyond the tail of the slope on either side. After the turf has been removed the layers composing the bank should be stripped off one by one, in the reverse order of the original building, until the old turf line beneath the bank is reached and removed.

Great care should be taken to search for evidence of two or more periods of construction, for stone, timber, or turf revetment at the bottom of the slopes, and for the post-holes of a fence or palisade either in the body of the bank or in the solid rock beneath it. The section should be wide enough to ensure that such post-holes are found if they exist. Great attention should also be paid to the excavation of the old turf line beneath the bank, which may contain valuable evidence for the date of its construction. Care must be taken to distinguish between true banks, originally built with sloping sides, and decayed walls, which have a similar outward appearance. In the highland zone particularly a common method of defence is the stone wall, the front and rear faces being made in dry-stone work, and the broad central core filled in with rubble. Walls of *murus gallicus* type have in addition internal timbering, which will be represented as cavities or as patches of finer filling, where the timber has decayed. The inexperienced excavator, unless warned of the possibility of the presence of such structural details, may easily cut through and destroy them unrecognised.

In the excavation of steep banks, where the soil is to be dumped at the side of the cutting, stout posts must be driven

[1] See van Giffen, A. E., *Die Bauart der Einzelgräber*, Leipzig, 1930.

in along the slope, against which planks or sheets of corrugated iron are fixed to prevent the dumps sliding downhill.

Ditches. Ditches should always be sectioned at right angles to the direction in which they run. The section should be long enough to include the nearer edge of any bank which may remain, and it should be wide enough to allow for the batter of the sides and a width of at least 3 feet at the bottom.

Since the width of the section must depend upon its probable depth, it is as well to be able to estimate this depth in advance. Few ditches are deeper *below the level of the subsoil in which they are cut* than half, and often no more than a third of their width at that level. On certain loose subsoils, such as gravel, where the sides of ditches are normally eroded to the angle of rest by weathering, the depth of the bottom can be calculated if this angle is known. The angle of rest of gravel, for instance, is about 33°, from which it may be calculated that no ditch cut in this material is likely to be deeper than one-third of its width; this is only true, however, if the ditch was allowed to silt up naturally. If it was deliberately filled, the original shape will have been preserved, and this may well be deeper than the width of the upper edges.

If the site can be dated roughly before excavation, this will also give some information about the shape and size of the ditches. In the Neolithic and Early Bronze Ages ditches tend to be flat-bottomed and U-shaped, with a depth which is shallow compared with the width. Later, however, in the Iron Age and the Romano-British period, the sections are more V-shaped and deep for their width.

In the excavation of shallow ditches up to about 7 feet from the surface, it is possible to throw up the soil with the shovel on to dumps at the edge of the trench. The top of the dump should be flattened and its inner edges trimmed back periodically, to prevent the earth falling back into the cutting.

In trenches deeper than this it will be necessary to dig out the filling so as to leave a series of deep steps or platforms on one slope. A man is stationed on each step, and the earth is either shovelled up in a number of stages, or is handed or

hoisted up in buckets. In either case the earth must finally be taken away in barrows, as a dump on the edge of a deep trench is very dangerous.

With the exception of the steps just mentioned, the filling of a ditch should always be removed layer by layer. Deep layers of silting should be subdivided, for recording purposes, into spits about 1 foot deep.

Needless to say, special attention should be paid to the excavation of the primary (i.e. the lowest) layer of silting, in which objects contemporary with the cutting of the ditch are most likely to be found.

It may often be necessary to determine the order of construction of two ditches which cross one another. To do this the course of the ditches in the neighbourhood of their junction must first be found by probing, resistivity surveying, or the

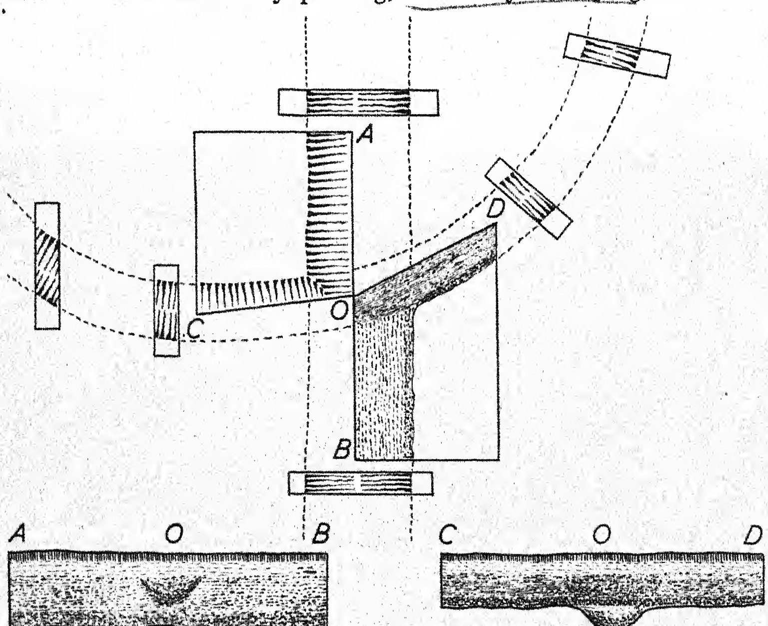


Fig. 11

cutting of trial trenches, and an estimate made of the point where their respective centre-lines cross. Two cuttings are then laid out round this point in the manner shown in Fig. 11, so that the sections AOB and COD correspond approximately with the centre-lines. Examination of the sections should then show which of the two ditches is cut through the filling of the other (Fig. 11). In certain cases the relative dates of the fillings can be seen in plan, as in Fig. 11, where the darker filling of the smaller ditch is continuous, and must therefore have been deposited later than the filling through which it cuts; but except when time is very limited, such observations should be checked by completing the excavation to expose the full depth of the sections.

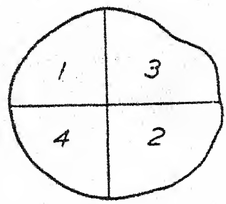
Where the ditches cross obliquely the cuttings should be placed in the obtuse angles of the junction, in order to give greater freedom of movement to the excavator.

Each longitudinal section will be in two parts separated at the point of junction, which can only be seen from opposite directions. In plotting the sections, one part should be turned back to front and joined to the other to give a continuous section.

Pits and post-holes. All pits should be sectioned across a diameter, right to the bottom. Very large pits may be dug on the quadrant system (Fig. 12), to expose two sections at right angles; the quadrants should be excavated in turn to the bottom in the order of numbering. In smaller pits only one section will be possible. If the half-section is too small to accommodate the worker comfortably, digging should be carried out in the order shown in Fig. 13. Block 1 is removed first, and the exposed section *AB* drawn; block 2 is then excavated, leaving a small earth wall, 3, to prevent the loose earth from falling into the part already dug. This wall is then itself pushed down and broken up, and the process begins again with the excavation of block 4 and the drawing of the next piece of the section *AB* thus exposed.

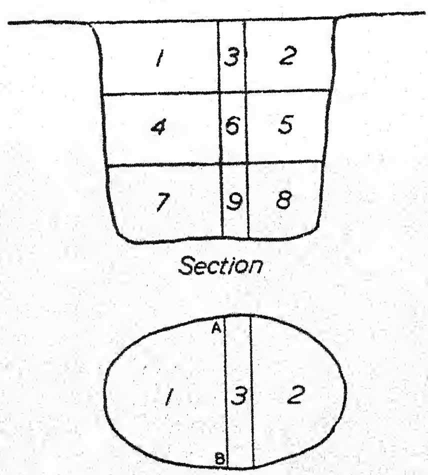
In the case of very small pits it will be necessary to cut away the undisturbed subsoil on either side of the pit itself, in order that the worker shall have enough room to cut a proper diametric section.

It cannot be too strongly emphasized that every pit, large or small, should be sectioned, even if it contains an object such as a pot. Unless this is done the stratification cannot be properly recorded or appreciated.



Plan

Fig. 12



Plan

Fig 13

Storage-pits should be carefully examined for traces of a clay, leather, or wicker lining, and for the presence of grain and

other vegetable matter, or the bones of rats and mice which may originally have been attracted by it. Rubbish-pits should be excavated with great care, as the stratification is often complex and the finds numerous.

Post-holes should be excavated by the same methods as small pits, great care being taken to search for packing material and traces of the stump of the original post. This can often be seen as a core of darker soil in the middle of the filling, although the wood itself seldom survives.

In the excavation of very large post-holes provided with ramps for the erection of the posts at least one section should be cut across the hole and ramp together to establish the relationship of their fillings.

Great care must be taken to distinguish real post-holes from the holes made by rabbits, moles, and other animals. The latter are usually irregular in shape and are filled with fine soft earth quite different from the compact filling of a post-hole.

Whenever post-holes are found cut into the natural subsoil, the greatest possible care should be exercised in finding out whether any traces of adjacent posts remain in the overlying topsoil. If any such traces are found, in the form of dark marks in the soil, they should be excavated by the scraping method, that is, by shaving off the soil in a series of thin horizontal layers of regular thickness. From plans drawn at each level and subsequently superimposed in their correct positions to scale, it will be possible to reconstruct the timbers far more certainly than could be done from the ground-plan alone.

The post-holes of a timber building should be sectioned only after the whole ground-plan has been uncovered, drawn to scale, and photographed. For photographs a wooden gardener's label painted white should be fixed upright in the centre of each hole, unless the filling contrasts sufficiently clearly with the surrounding ground to stand out by itself.

In the highland zone post-holes are often shallow and irregular in shape, and not easily to be distinguished from the surrounding natural material in which they are dug; they normally contain a softer earthy core at the centre, representing the decayed post and sometimes containing fragments of carbonised wood,

surrounded by packing-stones. Close-set lines of posts are often set in a palisade-trench, from which the packing material should be removed only after the individual post sockets have been identified, cleaned out and recorded.

It should not be assumed that post-holes will be found only upon unencumbered ground. Recent research has shown that they may occur in the ruined turf or stone walls of huts.

Graves. Graves must be excavated with the greatest care, using only the trowel and brush. Digging should begin at the sides and the filling should be removed towards the middle in layers about 2 inches thick. No rule can be laid down as to whether the grave should be dug in two parts to expose a vertical section; this may be done in the upper part of the filling, but is hardly practicable when the body is reached, unless the grave-pit is very large and provides plenty of working space round the centre. The method should be tried, however, when it is possible, as a vertical section may reveal many details would be otherwise missed.

The utmost care should be given to recording the exact position of all grave-goods, especially composite objects such as necklaces; for this purpose the recording-frame described on p. 136 should be used. A careful search should be made for traces of wooden or wicker coffins, purses, weapon-sheaths and shoes of leather, and the wooden or horn handles of weapons, whose presence may be indicated by surviving metal parts and fittings, or merely by stains. Whenever possible grave-goods should be carefully cleaned and left *in situ* until the body has been uncovered, so that the whole of the contents of the grave may be photographed together.

The excavation of grave-goods requires the greatest care and patience. The earth must be loosened by very gentle tapping with the point of the trowel or pen-knife, and allowed to dry before it is blown or brushed away.

The excavation of graves which are likely to contain metallic objects can be greatly aided by the use of electrical metal-detectors (p. 38).

Skeletons. Skeletons need as much care as the grave-goods which accompany them. The excavator should have a working

knowledge of human skeletal anatomy, sufficient to enable him to identify the bones as they appear and to predict the position of the remainder; he should also be familiar with the most common attitudes in which bodies are buried.

Normally the skull will be found first, as it projects upwards more than the rest of a supine body. This should be cleared first; then the lower part of the body should be uncovered and the legs found. These are followed up to the feet and pelvis, and the arms are then found and followed to the hands and shoulder. Finally the hands, feet, pelvis, vertebrae, and ribs, which are the most delicate bones, and have hitherto remained protected by the soil, are carefully uncovered and cleaned.

The most fragile bones are the blades of the scapulae, the innominate bones, the ribs, the nasal bones, the spines of the vertebrae, and the cheek-bones. They are usually more or less decayed and often of paper thinness. Great care must be taken, too, not to dislodge the bones of the hands and feet, the knee-caps, and the teeth.

The earth should be loosened from the bones with great care, so as to leave them standing out of the soil. When they have been brushed clean they should be allowed to dry for a little, which will restore some of their whiteness and improve their appearance for photography.

When photographed the bones should be carefully taken up one by one and packed for later examination by an anatomist. If possible, all the bones should be preserved; but where time is short or the bones are badly decayed only the most important should be kept. These are the skull and lower jaw, with the teeth, the long bones of the legs and arms, and the whole of the pelvic girdle (i.e. the ossa innominata, the ilia, the ischia, the sacrum and the coccyx).

Cremations. Whenever possible a deposit of cremated bones should be removed in a solid block and carefully packed for later dissection and study at home. In this way there is less risk of damaging the brittle fragments, which are often awkwardly placed at the bottom of a narrow pit, and difficult to pick out singly.

Where large numbers of cremations are found without urns it may be necessary to examine them on the site. Each cremation should be removed, as far as possible in a single lump, with its adherent soil, and placed in a labelled bucket. The material is then gradually washed free from soil on a suitable sieve or perforated metal tray, whose meshes should not exceed 3 mm. in diameter. The washed bones are then spread out to dry, and fragments of teeth and any grave-goods picked out by hand. When dry, the small stones and unidentifiable fragments of bone can be separated by passing the material through a sieve of ¼-inch mesh. The larger stones and other foreign matter must then be picked out by hand, and the residue of cremated bone placed in a stout labelled paper bag to await expert examination. The material passing the ¼-inch mesh should be thrown away only after very careful examination, as it may contain fragments of teeth, bone pins, flint, and other artefacts previously overlooked.

Masonry buildings. When a wall has been uncovered by a trial trench it should be traced by probing, or, if this is not possible, by a series of short additional trenches. One or more small pits about 40 inches square should then be sunk within the building against the wall down to the level of the floor, or, if there is no sign of this, to the natural subsoil, in order to determine the order of stratification.

Once something is known of the stratification the debris filling the room may be stripped off layer by layer, leaving a baulk not less than 2 feet wide running right across the room and two opposite walls. The remaining walls should also be bridged by baulks which extend right up to the surface (Fig. 14). The purpose of these bridges is to make quite certain which layers run right across the remains of the building, and therefore post-date its destruction, and which are confined within its walls, and therefore contemporary with its use.

Once all the layers have been removed and the necessary sections drawn, the baulks may be dug away. Marks should be left to indicate the position of the main section and its datum-line. The excavation may then be completed by digging away the floor down to the undisturbed subsoil, once more

leaving a baulk to complete the section on the original line. Finally, one wall should be breached and a cutting dug through

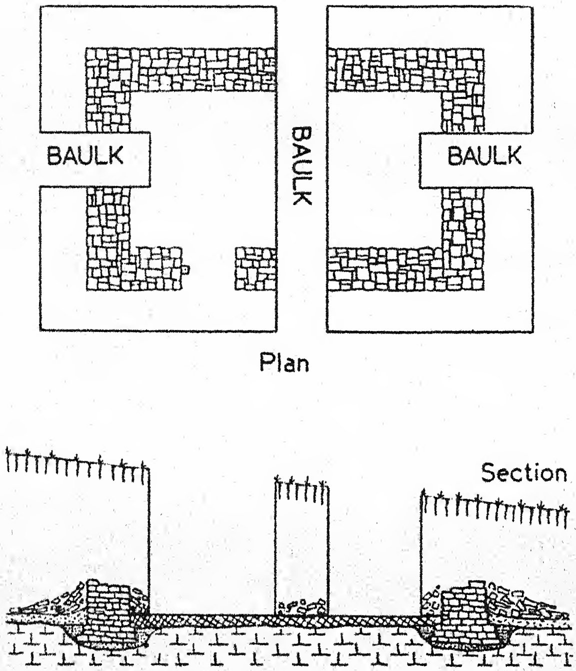


Fig 14

its footings to expose the method of building the foundations. Needless to say, the walls and floors should only be breached when the building as a whole is destined for destruction: in other cases it may be desirable to leave the structural parts of the building intact for preservation.

In Romano-British buildings early rubbish-pits, ditches, furnaces, and other structures are often sealed beneath later floors, and are usually to be detected by the subsidence of the floor over them. These structures should not be excavated

until the whole of the overlying floor has been uncovered, and then only if the latter is unimportant enough to allow its partial destruction.

On many Roman and later sites where ancient buildings have once stood, the stone will have been partially or completely robbed from the walls and foundations for re-use elsewhere. In such cases the walls can be traced only as 'robber-trenches', which can be seen in section, and it will be necessary to lay out frequent transverse cuttings to determine their course. A section incorporating a robber-trench and the remains of a wall is shown in Fig. 68, 4.

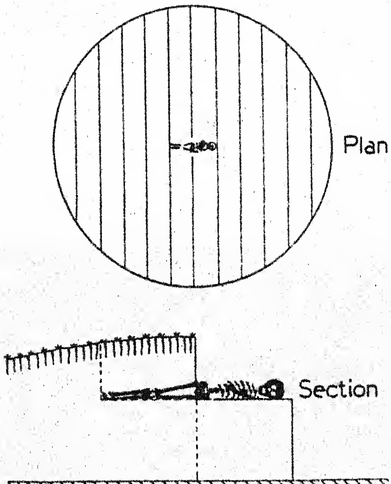


Fig 15

Barrows. For the excavation of round barrows two methods have become more or less standardized, in both of which the object is the complete removal of the entire mound.

In the first or *strip* method the mound is divided into a number of parallel strips 3 to 6 feet wide. In each strip the soil is removed one layer at a time down to the natural subsoil, before the next strip is tackled. When a large find such as a

skeleton projects from one strip into the next the cutting should be extended to include the whole find, and the excavation continued by layers as before (Fig. 15). Sections should be drawn of the face of each strip as it is exposed, from which the construction of the whole mound can later be worked out.

In the *quadrant* method the mound is separated into four quadrants by baulks not less than 3 feet wide. The soil is stripped off each quadrant in turn, layer by layer, until only the baulks remain to give two diametric sections of the mound. Finally, these are themselves excavated one by one (Fig. 16).

Although the aim in excavating a barrow should always be the complete removal of the mound, there is often (in rescue-

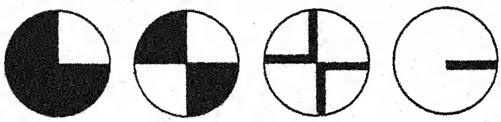


Fig 16

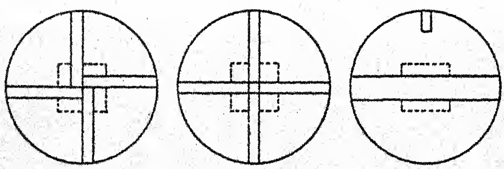


Fig 17

work, for instance) insufficient time to carry out so extensive an operation. Instead, modifications of the quadrant system are employed, three of which are shown in Fig. 17, the preliminary trenches are marked in bold lines, and later extensions are dotted. It should be noted that in all cases digging should begin at the outside of the mound and continue towards the centre; and the outside edge of the mound and the ditch, if there is one, should be found in at least three places, so that the centre from which they were originally laid out can be calculated (p. 96).

The excavator of a barrow should always be on the look-out for traces of more than one period of construction, for secondary inhumations or cremations, for turf work or revetting in stone or wood, and for timber structures in the body of the mound. The latter in particular are easy to miss without constant observation; and nothing is more mortifying than to realize, on discovering the ground-plan of a stake or timber structure, that one has unwittingly dug away the most important part.

The quadrant method of excavation described above may be used for any approximately circular site, whether it is visible on the surface or not. For small sites four radial baulks will be sufficient; for those exceeding 50 ft. in diameter it is advisable to use eight baulks equally spaced at 45° intervals, with cross-baulks connecting them at about 1/3 of the distance from the circumference to the centre; the actual position of the cross-baulks will depend upon the underlying structures which it may be desired to section.

THE EXCAVATION OF FRAGILE OBJECTS

Objects of metal and pottery are often found in a very fragile state, and their removal is attended by a considerable risk of damage. This risk can be lessened by allowing the object to dry thoroughly before touching it, and in the case of pottery drying can be hastened by the very careful use of a paraffin blow-lamp. It is preferable, however, to remove the whole block of soil in which the find is embedded, and to complete its excavation under safer conditions at home.

To do this the object is first isolated on a block of soil, the top and sides of which are covered by one thickness of damp tissue paper. Over this is wound a broad surgical bandage which has been dipped into liquid plaster of paris,[1] until a casing about a quarter of an inch thick is built up. When the plaster has set hard the base of the earth-block is sawn through with a fine wire and a plate of thin sheet iron gently eased into the cut. The whole block is then gently turned over so that

[1] Special surgical bandages impregnated with plaster are obtainable, which only require wetting before use.

the bottom can be similarly treated. Finally, the whole encased block is gently lowered into a strong wooden box and packed round with straw, wood-wool, crushed newspaper, or sand.

The top of the plaster casing can be removed at home with a small saw; when it is first lifted great care should be taken to see that nothing adheres to its under side.

The same method can be used with melted paraffin wax, obtained from candles, in place of plaster. It has the advantage that the casing can readily be removed by heating alone, and the wax melted down for re-use; on the other hand, plaster needs no heating apparatus on the site and is very much stronger. Complete pots should be removed with their contents intact for later examination in the museum or laboratory. The soil should be carefully loosened from the outside of the pot, and the latter then firmly wound from top to bottom with several layers of 'Prestoband' bandage. This bandage adheres to itself but not to the object which it encases.

SAMPLES AND MATERIALS FOR ANALYSIS

A list is given here of various special finds and samples which the excavator should collect and submit to an expert. Opportunities of gaining additional knowledge by these means are often overlooked; the taking of samples should be a routine part of every excavation.

Human bones should be preserved for examination by a physical anthropologist, who may be able to determine from them the age and sex of the individuals, their height, and the ethnic group to which they probably belonged. This information is derived chiefly from the skull and lower jaw, the limb bones, and the pelvis, which are accordingly the most important bones to preserve. Examination of these and other bones may also reveal signs of disease, wounds or fractures. Cremated bones should be preserved as carefully as skeletons. Recent work on Continental cremations has shown that in many cases it is possible to determine both the sex and the approximate age at death of the body cremated.

The identification of *animal bones* by a zoologist will throw light upon the food supplies and economy of an ancient com-

munity; and careful comparison of the skeletal characteristics with an established series may show how far the community concerned understood and practised the art of stock-breeding.

Objects of *metal*, and in particular of bronze, should be sent to a metallurgist. Analysis will reveal the composition of the alloy and the presence of impurities, from which it may in some cases be possible to determine the source of the ores used. No attempt should be made to clean metal objects before sending them for examination, apart from the removal of superficial dirt. Excessive washing or drying should be avoided, as changes in humidity are one of the chief causes of corrosion; so far as possible, therefore, metal objects should be packed to retain the same degree of moisture as the earth in which they were found.

Tools and weapons of *stone* other than flint should be examined by a petrologist to determine their place of origin. Information of this kind is especially valuable in plotting the course of ancient trade-routes.

All *pottery* should be carefully examined for food remains, and for impressions of grain or other seeds, which may throw light on the food resources and agricultural activities of an ancient community. Potsherds bearing such impressions should be sent to a botanist, who may be able to determine the species of plant by making and studying a wax cast.

In recent years the archaeologist has been greatly aided by the new technique of *pollen-analysis*. In many parts of the country, especially in the Fenland and in Wales and Scotland, archaeological sites are associated with deposits of peat. At different levels in these deposits the proportions of the various tree-pollens will vary with the nature of the vegetation prevailing at the time the level was laid down. In this way a peat deposit provides the archaeologist with a relative time-scale expressed in terms of pollen, into which any find can be fitted by examination of the peat adhering to it.

Samples should therefore be taken from peat deposits at intervals of not more than 6 inches from top to bottom; the series so obtained will then provide a scale into which the

analyses of pollen from individual finds may be fitted. For a fuller explanation of the method and its results, the reader is referred to the works cited in the Bibliography.

Apart from its chronological aspect, pollen analysis of samples taken from old turf lines and structures built of turf or containing peaty soil, which are sealed by later deposits, can be of great value in indicating the character of the contemporary vegetation.

Snails, or, to give them their proper name, *non-marine mollusca*, provide valuable evidence of climate. One or two shovelsful of soil should be taken from suitable positions, such as the filling of pits and ditches, and carefully washed in a sieve to reveal the snails. Some of the smaller species have narrow, pointed shells only a fraction of an inch long, and some practice is required in recognizing them. When collected the shells should be packed very carefully and sent to the appropriate expert.

By examining specimens of *wood and charcoal* a botanist can determine the species, and also, in some cases, whether the wood has been burnt or charred or is merely decayed, a distinction which the untrained eye cannot make.

Wooden objects such as the handles of tools, which may be preserved under suitable soil conditions, must be packed as soon after excavation as possible. The form of such objects undergoes drastic changes in drying, and for this reason they should be kept constantly moist, preferably by immersion in water, but failing this by painting them with glycerine; the containers in which they are packed should be airtight.

Another technique which is becoming increasingly valuable to the excavator is that of *soil-analysis*. The archaeologist should be able to distinguish disturbed from undisturbed soil, and intentional filling from natural silting, but the subtler problems of soils are a matter for the expert soil-scientist.

For instance, the excavator of a barrow on heathland may find that the old turf line beneath the mound consists of white sand, whereas the corresponding level outside the barrow on the heath is of dark, almost black sand. He needs to know whether the white sand has been purposely put down as a part

of the ritual of building the barrow, or whether it is merely a real old turf line which has been bleached white by the chemical action of surface water percolating through the mound. Again, a turf-filled grave-pit may be found to contain half-way up in the filling a thin layer of white sand. How did this sand get there? Was it blown by the wind, deposited by water, or what? Or again, a dark band of soil is found running across the silting of a chalk-cut ditch. Was this soil thrown in, or is it an old turf line formed naturally between two periods of silting? All these are problems which the soil-scientist may be able to solve.

Soil-analysis is a complicated business requiring special training and knowledge. For this reason the excavator should make arrangements whenever possible for a geologist trained in this work to visit his site, so that he can see the soil problems on the spot and himself take all the necessary samples. Unfortunately a personal visit of this kind may frequently be impossible, and in this case the excavator must take what samples he thinks necessary and send them for examination.

Wherever a soil problem occurs samples should be taken at intervals of 4 to 6 inches right through the strata from the surface to the natural subsoil. As far as possible each sample should be removed and packed in a solid block, whose top and bottom surfaces should be indicated. This can only be done, however, in compact, fine grained soils; coarser and more friable material will inevitably crumble on removal. The volume of the loose samples should not be less than two heaped tablespoonfuls. For each series of vertical samples a control series should be taken to the same depth through undisturbed natural deposits, as close as possible to the series under examination. When securely packed the samples should be sent to the soil scientist with full details of the problems raised and notes and diagrams of the stratification involved.

LABOUR

The archaeologist faced with the task of conducting a small excavation of the type described in this book has a choice, in theory at least, of two sources of labour. Either he may call upon his friends, his colleagues, members of his local archaeo-

logical society, and other amateurs; or he may go to the local Labour Exchange and engage professional labourers or navvies.

It may be said at once that where such a choice really exists the navvy is to be preferred *for actual digging* to all but the most skilled and conscientious amateur, for, in the words of the song, 'Enthusiastic amateurs are a damned sight worse than pro's!' In the writer's opinion the ideal labour force for the small excavation consists of a few navvies with previous experience of archaeological digging, under a good foreman, and one or two experienced amateurs to help with the recording, surveying, and photography, and to do the more delicate digging. Unfortunately, however, this ideal is seldom attained, and the excavator is forced through lack of funds to rely upon unpaid, and often unskilled, amateur labour.

The increasing shortage of money and of available professional labour has in the last few years profoundly affected the organisation or archaeological excavations, and it is now common for quite large sites to be dug entirely by students and other volunteers, of both sexes. In the present writer's experience, there is no shortage of such voluntary labour, particularly if limited funds are available for the payment of a nominal wage to those who cannot afford all their own expenses while digging away from home. On some recent excavations, where a wage of 1s. 4d. per hour was paid to about half the volunteers engaged, and bus fares to and from the site were refunded, it was found possible to complete the work at under half the cost of employing an equivalent force of professional labourers.

This increasing use of unskilled voluntary labour provides opportunities of training beginners which would otherwise be less frequent, and for that reason it is to welcomed. It is necessary, however, that the director of excavations who intends to rely largely or solely upon volunteers should realise clearly the limitations of this kind of labour. Few amateurs can match the navvy in staying-power and neatness, when working with pick, fork and shovel; and though the intelligent and experienced amateur is certainly better than the average labourer at delicate work with trowel and brush, many amateur volunteers are necessarily beginners, whose enthusiasm and lack of experience

may combine, with the best of intentions, to do irreparable damage. The initial lure and fascination of discovery may lead to unseemly haste; and once the first thrill has worn off, as it must do on all but the most productive and varied sites, indifference and carelessness, no less dangerous, may follow.

For this reason any body of volunteer excavators must include a number of members with previous experience of excavation, preferably on the same type of site, who, by example and by actual instruction, can guide the work of beginners. Even so, the director will find that the greater part of his time is occupied in the supervision and instruction of volunteers, and that the work of surveying, recording and photography must be fitted in at odd moments of the day, and even in the evenings after the actual digging has finished.

The supervision of volunteers, and particularly of beginners, requires far more patience, tact, and imagination than is often realised. To the beginner all the features of a site and the process of its excavation, which appear simple and self-explanatory to the experienced digger, are bewildering and meaningless. Indeed, he is often literally not able (and cannot fairly be expected) to see the apparently quite obvious differences of soil and structure which must determine the way he should perform the particular task allotted to him. For this reason the director must be prepared to expend much time and patience in minute explanations and careful demonstrations, and must frequently visit each volunteer during the course of the work. It is unsafe, and equally unjust, merely to leave the inexperienced worker to get on by himself with a job which he understands at best imperfectly, and to expect him to complete it satisfactorily without guidance and supervision.

An excavation done by volunteers must be organised in such a way that work of varying difficulty and responsibility is available at all times to suit the varying experience and capabilities of the workers. Mistakes, sometimes serious ones, are bound to be made, and it is only right that they should be clearly pointed out. Much tact is needed to do this with sufficient emphasis yet without discouragement, and it is wise to keep in reserve certain pieces of work, so that the efforts of the in-

corrigibly careless or untidy digger (and the employer of volunteers must be prepared for these) can be directed in harmless but still profitable directions.

If camping facilities or meals on the site are provided for volunteers, it is essential that the organisation of these services should be undertaken by persons who are solely responsible for them, and take little or no part in the work of the excavation. To attempt to combine the running of a camp or canteen with the direction of an excavation simultaneously is almost invariably disastrous for both.

Lest it be thought that the present writer is guilty of a prejudice against all amateur labour, it should be made clear that he has conducted a number of pleasant and successful excavations on this basis. The employment of *inexperienced* volunteers, however, though it provides excellent opportunities for training, does profoundly modify the organisation of a dig and the responsibilities of the person directing it; and it is only fair to intending directors and volunteers alike that this should be emphasised.

If he employs paid labour the archaeologist must know how to get the best from his men. He must remember that he will be regarded as an amateur employer, perhaps even as a crank, and possibly, therefore, as fair game; it is here that the services of a good foreman are invaluable. So far as his special tasks permit, the employer must share the heavy work with his men, and should give them opportunities of helping him with surveying and measuring; an attitude of aloofness and mistrust only engenders in its turn mistrust and inefficiency.

He must remember too that archaeological excavation has its own standards of value, which are different from those of his men; these he must endeavour to re-cast, to make it plain that the object of the work is not to collect things from the earth, but to collect information, and that as evidence the meanest potsherd is often of more value than the largest gold coin. He must not try to force information upon unwilling ears, but he should encourage an interest in the work and the finds and answer questions about them simply but fully. Only by inculcating a real interest in the work, and a proper under-

standing of *archaeological* values, can the excavator hope to attain a high standard of digging and avoid the troublesome difficulty of petty thefts.

Wages are usually paid for work by the hour; the rate paid should be the local one for this type of work, which can be ascertained from the local Labour Exchange. The normal working hours are from 8 a.m. to 5 p.m., with an hour for lunch and a short break for 'elevenses'. Overtime is usually paid for work in excess of eight hours each day; for Saturday afternoons one-and-a-half times and for Sundays and Bank Holidays twice the ordinary rate is normally paid, though these rates vary locally. Wages should be paid promptly at the end of each Friday. The practice of 'subbing', that is, of advancing a portion of wages not yet due, is not to be encouraged. Insurance cards should be stamped every Monday, and delivered to the workman when he is finally paid off. Employment can usually be terminated on one day's notice, but it is only fair whenever possible to give longer notice than this.

For particularly unpleasant work, such as digging in water-filled ditches, a small bonus may be paid. If a workman breaks his own tools during working hours they should be replaced for him free of charge.

The question of extra payments for all finds, or for those of particular interest, is a controversial one. It may be argued that to set a cash value on finds encourages petty theft, since the payment per find cannot be very large, and there is always the hope of obtaining a better price elsewhere. On the other hand, if it is made quite clear that the payment made represents the *archaeological* value of the find, and has no relation to its cash value, which in almost all cases is nil, the system provides an element of competition and chance which should encourage careful digging and accurate observation.

If the principle of payments is adopted, the best system is to give the finder a slip marked with his name, a description of the object found, and the sum to be paid, and to enter these details on a counterfoil which the excavator retains. The slips may then be presented for payment on Fridays with the wages.

Archaeological excavation, like any other activity, has its physical hazards; accidents do occasionally happen, and it is the responsibility of the director to prevent them. In deep trenching, dumps should always be kept at a distance, and the sides of the trenches should be stepped if required (p. 61). It is also wise to take out an insurance policy (the premium is not high) against injury to workers, whether they be labourers or volunteers, paid or unpaid. The employer of amateur labour should remember, moreover, that, in the hands of the enthusiastic but inexperienced digger, excavating tools can be dangerous and even lethal weapons. The present writer has on two occasions seen a volunteer put a fork through his foot; he has also seen a man's trousers removed neatly by a careless swing of a pick which, had it been an inch longer, would almost certainly have been fatal. Any open wound sustained on an excavation may lead to lockjaw, and in such cases prompt attention by the nearest doctor, including an injection of anti-tetanus serum, should be insisted upon. Needless to say, every excavation should be equipped with an adequate first-aid box, and the address and telephone number of the local doctor should be displayed on the site.

THE RESTORATION OF EXCAVATED SITES

On rescue-work sites, where the archaeological material is in any case eventually to be destroyed, the question of restoration does not arise. In other cases, however, restoration of the site to its condition before digging began must be regarded as an integral part of the excavation.

Normally it will be sufficient to replace the soil in the cuttings without ramming it down, except for an occasional trampling with the feet, leaving the excess soil standing up in a mound on which the turf is neatly replaced; with the gradual consolidation of the lower filling the turf will eventually sink to ground-level.

When it is necessary, however, to leave the surface level in the first place, each layer of soil shovelled back into the trenches must be rammed hard with a heavy rammer, especially at the corners. The turf should be relaid closely and neatly, and watered to prevent it withering.

The restoration of barrows and other earthworks which have been completely removed to ground-level is more complicated. It is essential to have a contoured plan of the monument before excavation, which is now to be used as a basis for the reconstruction. The soil should be put back in layers about 1 foot thick, each layer being rammed hard and trampled down, and the limits of the next layer above marked out on it. When all the layers have been put back the sides are smoothed off and the turf replaced. It will be found that not even heavy ramming will entirely compress the soil to its original volume, and the completed reconstruction should therefore be 5 to 10 per cent higher than the original monument to allow for subsequent setting. On sites in the highland zone, where the material is largely stone rubble, particular care must be taken in refilling trenches; rubble settles only slightly with time, and if it is not tightly packed large quantities will remain over, and the site cannot be made tidy.

Excavations involving the discovery of buildings of dry-stone walling will often not be filled in, so that the structure can remain visible. In such cases particular care must be exercised in the location and construction of the dumps, so that they can be readily distinguished, at a later date, from the structure proper.

It may be added that excavators would do well to follow the example of General Pitt-Rivers in placing at the bottom of restored sites a lead plaque bearing a record of their excavation, that they may not deceive, though they may disappoint, the excavators of the future.

PART II THE RECORD OF THE EVIDENCE

III. ARCHAEOLOGICAL SURVEYING

EVERY archaeologist should be able to make clear and accurate plans of the sites which he investigates. To do this requires no special ability, for surveying is not the complicated and abstruse business it is commonly supposed to be; nor does it require expensive and delicate instruments, nor more than a schoolboy's knowledge of mathematics. What it does require is a sound knowledge of a few elementary principles and plenty of common sense.

Before passing on to these principles there are one or two points to be noticed, which if properly understood will save the beginner in surveying much time and worry. The first of these points concerns errors. Errors are of two kinds, personal and instrumental. Personal errors, such as reading or writing down a figure wrongly, are avoidable. Errors arising from the instruments used, on the other hand, cannot be avoided, and indeed cannot even be detected in all cases; for we can never know the true value of a measured quantity unless we have perfect instruments, and we can never know whether our instruments are perfect unless we have other perfect instruments with which to test them, and so on, in an infinite regress. We cannot, therefore, get rid of errors; but we can, by comparing our instruments with known standards, make certain that the errors which they produce are kept within reasonable limits.

Since all instruments have inherent errors of some degree, it will be obvious that the accuracy of any two or more instruments used together cannot exceed that obtainable with the least accurate of them used singly. It is, therefore, quite useless to attempt great accuracy of measurement unless all the instruments used are equally capable of that degree of accuracy; it is no good, for instance, spending extra time measuring angles

to the sixtieth part of a degree with an expensive and delicate theodolite, if the corresponding distances are measured by the very rough method of pacing. The more common instruments and methods of measurement may be divided according to their relative accuracy as follows: for rough work, pacing and the prismatic compass held in the hand; for ordinary mapping work, the linen measuring tape and the prismatic compass supported on a tripod to steady it; and for the most accurate surveys, the steel tape and the theodolite. (Note. Surveying instruments are described in a separate section, p. 127).

In matters of accuracy the archaeologist, as an amateur surveyor, cannot hope to compete with the professional. It is not always desirable, however, that he should even attempt to do so. Apart from the fact that great accuracy requires extra care and time, there are certain reasons why it is wasteful for the archaeological surveyor to attempt more than a certain degree of accuracy. The professional surveyor and the civil engineer are concerned with the exact measurement of areas and the location of positions for structures of definite size. The archaeological surveyor, on the other hand, deals largely with things such as earthworks which have no definite dimensions, so that he is often free, within limits, to take as the boundary of what he is measuring those points which suit him best. For instance, if the position of the bottom of a sloping bank is being measured, it is useless to choose a point, say, 19 feet 7½ inches from the base-line, when by moving the point only 4½ inches it will be possible to write down the much more convenient figure 20 feet, without in any way being guilty of inaccuracy. For the position of the bottom of the bank is not exactly fixed, because earthworks do not have sharp corners and angles; all that can be said is that the bottom lies somewhere between two points, one on the slope and the other on the flat ground, and it is of no consequence which point between these limits is chosen for the purpose of measurement.

It will be clear, therefore, that the archaeologist in many cases can take his measurements to the nearest foot, or even two feet, without in any way detracting from the accuracy of his results, which means a considerable saving of time and

calculation. It should be realized, however, that this applies only to things such as earthworks which have no sharp boundaries; such licence is obviously out of place in dealing with masonry buildings and other structures with dimensions exactly fixed.

There is yet another reason why it is useless to attempt more than a certain degree of accuracy. Every map is a representation of a piece of ground at a certain scale; boundaries on the map are represented by lines of a definite thickness, and this thickness is equal to a definite distance on the ground, according to the scale. A fine pencil line, 1/50 inch wide, represents a distance of 2 feet at the scale of 1 inch to 100 feet, and over 100 feet at the scale of 1 inch to 1 mile. If, therefore, we take measurements from a base-line on the ground, and represent that base-line on our map by a line 1/50 inch wide, then at the scale of 1 inch to 100 feet any point 1 foot or less from the base-line on the ground will be 1/100 inch or less from the *centre* of the pencil line on the map; in other words, it will merge into the base-line, and cannot be represented at all. Obviously, therefore, *at this scale* distances of 1 foot or less are too small to be shown and can be ignored; so that we can measure all distances to the nearest even foot only, thus saving a good deal of time.

Similarly, at every other scale there is a limit beyond which accuracy cannot usefully be taken. A table of these limits is given on p. 217 (Table I), taking the average width of a pencil line drawn in the field as 1/50 inch. It must be understood, however, that these limits apply only when no calculations are involved. If some measurements are to be used to calculate others mathematically they must be accurate; approximations will not do. It should also be clear that the scale at which the map is to be plotted must be decided before the possible degree of approximation in measurements can be determined.

One other important convention in surveying requires notice here. A map is a representation to scale of the features of a piece of country, and the distance between any two points on the map multiplied by the reciprocal of the scale will give the real distance between those points on the ground. But what is

meant by the real distance between those points on the ground? Suppose that we walk, with an instrument for measuring the distance traversed, along the beach between two towns on a straight stretch of coast, and that we then walk back again up and down along the cliffs. Obviously the reading for the return journey will be greater than for the outward one; but which of these readings represents the *real* distance between the two towns? Clearly it is the smaller one, for the journey along the flat beach. All maps are made on this principle; in other words, they show, not the distances between points measured along the ground, *but what those distances would be if all the points were reduced to a common plane*, which for convenience is taken as sea-level.

Reference to Fig. 41 will show that the *slope distance* between two points *A* and *B* is always greater than the *horizontal distance AB′*; therefore when measurements are made on a slope a certain proportion must be subtracted to give the horizontal distance. This point is considered in greater detail on p. 108.

Since archaeological surveying does not normally require a high degree of accuracy there is no need to invest in expensive and delicate instruments. A linen 100-foot tape for measuring distances, a prismatic compass for measuring horizontal angles, and an Abney clinometer for vertical angles are all that is absolutely necessary, though additional instruments such as the cross-staff (or the optical square) and plane table will in certain cases save much time. The plane table can easily be made at home by any amateur carpenter, and the other instruments can be bought, second-hand if desired, quite cheaply. It is safe to say that an expenditure of £5 or £6, if wisely made, will easily cover all that the archaeological surveyor is likely to require.

THE FIVE BASIC METHODS OF SURVEYING

The fundamental principle of surveying is first to establish a framework of lines or points whose position is known, and then to use this framework as a reference for fixing the detail which is to be mapped. The principle is a very obvious one. No artist, for instance, would think of making a drawing by

starting at one corner of his sheet and working across his paper from there, filling in all the detail on the way; for before he was half-way across the sheet everything would be out of proportion, owing to the accumulation of small errors. Instead, he first draws in the main lines of his picture, so that he has a fixed framework to which he can refer the detail.

The surveyor works in precisely the same way. His framework may consist of actual objects, such as straight walls and fences, but more usually, because such really straight lines are rarely found, he lays down his own framework of arbitrary lines and points in the positions which suit him best. He then uses these lines as references from which to record the detail to be mapped.

There are five basic methods of fixing the position of a point with reference to known lines or points. All the operations of surveying consist of one of these basic methods or a combination of them.

1. *By co-ordinates* (offsets) (Fig. 18).

If the position of two points A and B is known, the position of a point C is fixed by two measurements; one, x, perpendicular to AB, the other, y, along AB from A. The measurement x is known as an offset from AB. Every schoolboy who has done 'graphs' is familiar with this method, which is the chief way of fixing detail in chain surveying (p. 99) and traverse work (p. 100).

2. *By distance from two points* (Tying-in) (Fig. 19).

If the position of two points A and B is known, the position of a point C is fixed by the intersection of two arcs drawn from A and B, of length AC, BC respectively. To fix a point by this method is known as tying it in. (Strictly speaking, there are *two* positions which satisfy these conditions, C and C'; a note must therefore be made of the side of AB on which C lies.)

3. *By direction from two points* (Fig. 20).

If the position of A and B is known, the position of C is fixed by the intersection of two lines of known direction drawn from A and B respectively. In plane tabling (p. 104) the direction of AC and BC is found by measuring the angles CAB, CBA;

otherwise their directions are found independently of *AB* by using the prismatic compass. This instrument (p. 133) gives the direction of *AC* and *BC* with reference to the fixed direction of Magnetic North, which is assumed to be constant at all

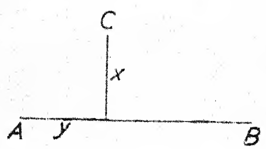


Fig. 18

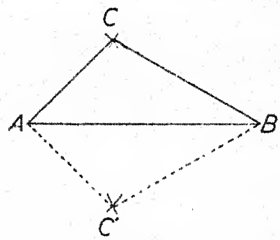


Fig. 19

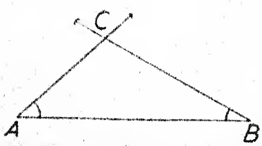


Fig. 20

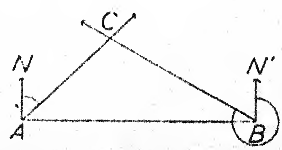


Fig. 21

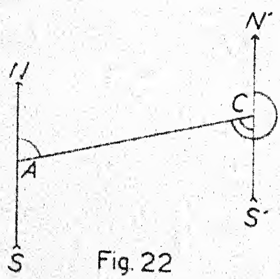


Fig. 22

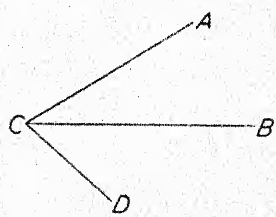


Fig. 23

points in a survey. Hence, with the compass it is the angles *NAC*, *N'BC* which are actually measured (Fig. 21).

4. *By direction and distance* (Fig. 22).

If the position of a point *A* is known, the position of *C* is fixed by the direction and length of the line *AC*. The direction

of AC is determined with reference to the constant direction of Magnetic North, by measuring the angle NAC with the compass; this angle is known as the 'forward bearing' of AC, or the bearing of C from A. The method is used in constructing the framework or 'legs' of a traverse (p. 100).

It will be clear from Fig. 22 that since NAS and $N'CS'$ are parallel straight lines, the angle NAC is equal to the angle $S'CA$, and that therefore *the bearing of* A *from* C is equal to *the bearing of* C *from* A plus 180° (the straight line $N'CS'$). The clockwise angle $N'CA$ is known as the 'back bearing' of the line AC. Hence we can formulate the following rule:

To find the back bearing of a line add 180° *or subtract* 180° *from the forward bearing, according as the forward bearing is itself less or greater than* 180°.

Thus the back bearing of a line whose forward bearing is 67° will be $67°+180°=247°$; and if the forward bearing is 324° the back bearing will be $324°-180°=144°$.

5. *By direction from three points* (Fig. 23).

If the position of any three points A, B, and D is known, the position of a point C is fixed if the direction of the lines CA, CB, and CD is known, or, in other words, if the angles ACB, BCD are known. It can be shown mathematically that if these conditions are fulfilled there is only one possible position for the point C, unless the four points A, B, C, and D all lie on the circumference of the same circle; in the latter case the position of C can not be fixed from the given points. This method is the basis of Resection in plane tabling (p. 211).

If these five basic methods are thoroughly understood the reader should have little difficulty in grasping the surveying procedures described later. He should also clearly understand the following applications of simple geometry to measurements in the field.

FIELD GEOMETRY

1. *To erect a perpendicular at a given point on a given line*

(*a*) *With the cross-staff or the optical square.* It is required to set out a line at right angles to the line AB at the point C (Fig. 24). The cross-staff is set up at C and a ranging

pole is placed at any point on *AB*; the cross-staff is turned until this ranging pole is visible through one pair of sighting vanes. Then without moving the staff the surveyor takes a sight through the other pair of vanes, directing an assistant to move a second ranging pole until it appears in the line of sight at *D*. The angle *ACD* will then be a right angle.

To do the same thing with the optical square, the instrument is set up on a staff or tripod at *C*, and a sight is taken through the lower clear portion of the object-glass on the ranging pole set up on the line *AB*. An assistant is then directed to move a second ranging pole until its image appears in the upper half of the object-glass immediately above the first. The second pole then lies on the required perpendicular at *D*.

(*b*) *With the measuring tape.* Mark off equal distances *Cp*, *Cq* along the line *AB*, on either side of *C* (Fig. 25); for preference these distances should be 30 feet each. The zero end of the measuring tape is pinned down at *p*, and an assistant holds the 100-foot mark at *q*. The surveyor then takes the tape at the 50-foot mark and pulls it out to *D* so that the sides *pD*, *qD* are straight and taut; the angle *ACD* will then be a right angle. To check the setting out the distance *CD* should be measured. If *Cp* and *Cq* were each 30 feet in length, *CD* should be 40 feet.

(*c*) *The* 3–4–5 *Method* (Fig. 26). The last method described cannot be used where the point *C* is so close to a hedge or other obstruction that the distance *Cq* cannot be laid out. In such a case either of the two following methods may be used.

From *C* measure 33 feet along *BA* to *p*, and pin the zero end of the tape there. An assistant holds the 99-foot mark at C, while the surveyor takes the 55-foot mark and pulls the tape taut to form two sides of a triangle. The point *D* at the 55-foot mark then lies on the required perpendicular from *C*. This construction depends upon the theorem of Pythagoras; the figures given are those for the largest triangle obtainable with one 100-foot tape,

but any series can be used provided they are in the ratio 3 : 4 : 5. For more accurate work, for instance, two tapes may be used, the distances *Cp*, *CD*, and *pD* being 60, 80, and 100 feet respectively.

(*d*) *The Semicircle Method* (Fig. 27). The following method has the advantage that no assistant is needed to hold down the tape.

Choose and mark with a pole a point *O* in the required right angle *ACD*, so that *OC* is not less than 30 feet. Measure *OC*, and swing the tape to cut *AB* at *p*, so that $OC = Op$. Put in a mark at *p*. Swing the tape round to the opposite side of *O*, and find a point *D* such that $OD = Op = OC$, and *D*, *O*, and *p* are in a straight line. Then *CD* is the required perpendicular.

This construction depends on a theorem which states that the angle subtended by the diameter of a semicircle at any point on the circumference is a right angle. Here the arc *pCD* is the semicircle and *pOD* its diameter; hence the angle *pCD* must be a right angle.

2. *To drop a perpendicular from a given point on to a given line*

(*a*) *With the cross-staff or optical square* (Fig. 24). It is required to lay out a line from a point *D* perpendicular to the given line *AB*.

Ranging poles are set up at *D* and at any point on *AB*. The foot of the required perpendicular is estimated and the cross-staff set up there, one pair of vanes being sighted on the pole on *AB*. Then without moving the staff the surveyor sights through the other pair of vanes. If this line of sight cuts the pole at *D*, the staff lies at the foot of the required perpendicular (*C*); if, on the other hand, the line of sight passes to the *right* of *D*, the staff must be moved along *AB* to the *left*, and vice versa, and the process repeated until the required position of *C* is found.

The same result can be achieved with the optical square, the instrument being set up on the line *AB* and moved along it until a position is found at which the images of the two ranging poles coincide.

(*b*) *With the measuring tape* (Fig. 28). For rough work the zero end of the tape is pivoted at *D*, and the tape is swung taut over the line *AB* (which must be marked by another tape or with string), until a point is found at which the

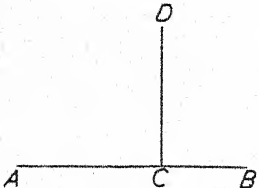


Fig. 24

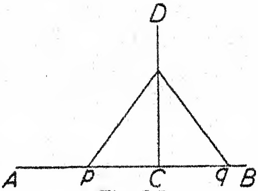


Fig. 25

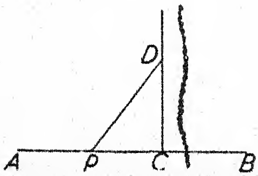


Fig. 26

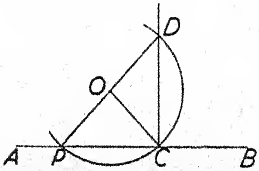


Fig. 27

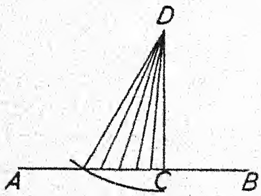


Fig. 28

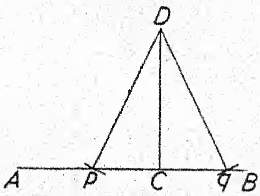


Fig. 29

reading on the pivoted tape is lowest. This point will be the foot of the required perpendicular. This method is the one usually employed in measuring offsets in traverse and chain surveying (pp. 99, 100).

For more exact work the tape is pivoted as before at *D* and swung taut so that the 100-foot mark describes an

arc cutting AB at p and q (Fig. 29). The point C midway between p and q will then be the foot of the required perpendicular. For accuracy the distances Cp, Cq should not be less than 30 feet, except in the case of very short perpendiculars. This means that if the distance CD exceeds 95 feet the 100-foot tape will be too short, and must be lengthened by adding a string to the zero end.

3. *To set out parallel lines*

It is required to set out a line PQ parallel to and at a given distance from the line AB (Fig. 30).

Erect perpendiculars at A and B, and mark on them two points P and Q at the required interval. The required parallel will then pass through P and Q. The setting out should be checked by measuring the diagonals AQ, PB, which should be equal.

Over long distances, where it would be difficult to measure the diagonals of the whole figure, short parallels PR, SQ are set up at either end of the line, and checked by measuring the diagonals as before. If the setting out has been done correctly the points P, R, S, and Q should all be in a straight line (Fig. 31).

The latter method is particularly useful where a survey line which must be measured is obstructed by an impassable obstacle. Fig. 26 shows the line AB, which is to be measured, obstructed between C and D by a patch of boggy ground which will not bear the surveyor's weight. Accordingly a parallel line PQ is set out, avoiding the bog, and the distance RS is measured. It is clear that this is equal to the required distance CD.

4. *To set out a grid of points*

A grid or network of points, equally spaced over an area, is often needed for purposes of recording finds (p. 143), for marking out trenches (p. 50), and for contouring (p. 118). Two methods are given below,

(*a*) *With the cross-staff or optical square* (Fig. 32). A straight line AB is set out diagonally across the area to be covered

by the grid, and is divided by pegs into equal parts of suitable length. By means of the cross-staff or optical square lines are set out at each peg at right angles to and on both sides of the central line *AB*, the ends of these lines at the edge of the area being marked with pegs by assistants. The tape is then stretched along each of these side-lines in turn, pegs being inserted at the same intervals as on the base-line *AB*.

(*b*) *With the measuring tape, without assistants* (Fig. 33). The surveyor first surrounds the area to be covered by the grid with a rectangle, measuring the right angles by any suitable method. Opposite sides of this rectangle are then divided into an *equal* number of parts, the interval between pegs being the same for all four sides. Two more lines similarly divided are then set out joining the centre pegs of opposite sides of the rectangle; the pattern of pegs will now appear as in Fig. 33. All the remaining pegs of the grid can now be placed by eye alone, without further measurement, each point being in line with four others already fixed.

5. *To find the centre of a circle*

This problem occurs frequently in the excavation of circular sites such as barrows and ring-ditches. At least *three* points on the circumference must be known, and should for preference be as widely spaced as possible.

(*a*) *By measurement* (Fig. 34). *A*, *B*, and *C* are three points on the circumference. Find and mark the mid-points of *AB*, *BC* at *D* and *E*. At these points erect perpendiculars *DF*, *EG*, which intersect at *O*, the centre of the circle. Check this result by measuring *OA*, *OB*, and *OC*, which should be equal.

(*b*) *By calculation*. The length of the radius of a circle, *R*, is given by the following formula:

$$R = \frac{abc}{4\sqrt{s\,(s-a)\,(s-b)\,s-c)}}$$

where a, b, and c are the lengths of the sides of the triangle

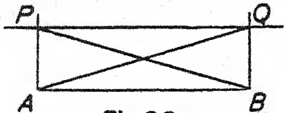


Fig. 30

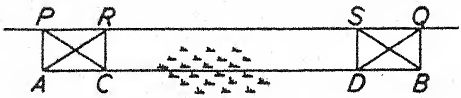


Fig. 31

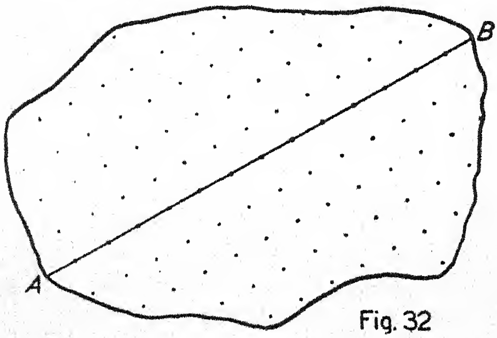


Fig. 32

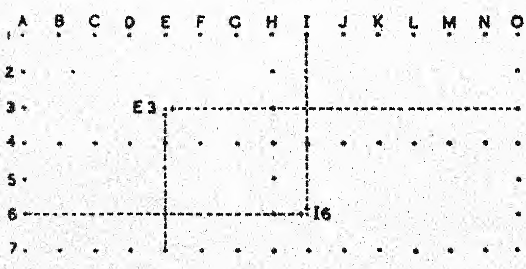


Fig. 33

ABC formed by the three known points on the circumference,

and $$s=\frac{a+b+c}{2}$$

Thus, if $a=32$, $b=60$, and $c=68$,

then $s=80$,

and
$$R=\frac{32\times 60\times 68}{4\times\sqrt{80\times 48\times 20\times 12}}$$
$$=\frac{130560}{3840}$$
$$=34$$

Once the radius has been calculated, the centre is found by pinning the zero end of a tape at each of two of the known points on the circumference, and grasping both tapes together at a distance equal to the calculated radius. When both tapes are pulled taut the surveyor's position will be at the centre of the circle.

6. *To set out a straight line between two points not visible from each other*

(*a*) *With the cross-staff.* Find a position between the two points from which both are visible. Set up the cross-staff and sight one of the points through one pair of vanes. Then, without moving the staff, sight the other point through *the same pair of vanes* in the reverse direction. If this line of sight cuts the second point the cross-staff stands on the required line. If on the other hand the line of sight passes to the *right* of the point sighted, the staff must be moved to the *left*, and vice versa, and the process of sighting and moving continued until the required position is found.

(*b*) *By reciprocal ranging* (Fig. 35). The distance between the vanes of the cross-staff is too short for great accuracy; where this is required the following method should be used:

X and *Y* are the two points between which the line is to be ranged. Two observers, *A* and *B*, take up positions as close to the estimated line as possible, so that *A* can

see B and Y, and B can see A and X. A then directs B, by signals if necessary, to move to b' where he is in line with Y; from there B moves A to a' in line with X; and from this point A once more directs B into line with Y at b''. This process is continued until both observers see the other in line with the point beyond him at the same time; X, A, B, and Y are then all in a straight line. Time will be saved if each move after the first is made a little farther than the observer actually directs.

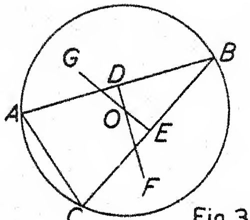


Fig. 34

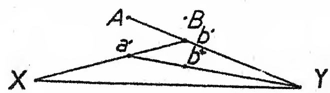


Fig. 35

In the following paragraphs a number of methods of surveying are mentioned briefly. Space does not permit the detailed description of individual methods, for which the reader is referred to the books listed in the Bibliography (p. 218); fuller treatment is given here only to methods specifically designed for use on archaeological sites.

Chain surveying, so called because the steel measuring-chain is the chief instrument used, is the simplest but the most tedious method of mapping. Except on windy or very rough ground the chain may well be replaced with a 100 ft. linen measuring-tape.

The framework of the survey consists of a series of connected triangles, whose sides run as close as possible to the detail to be mapped. Each side is measured in turn, offsets to the detail being measured and recorded as the work proceeds. Unless the survey includes at least two points whose position can be found on a map, the compass-bearing of one side must be taken to orientate the survey. The compass may also be used to fix by intersecting bearings the position of points which are too far

from a base line to be fixed satisfactorily by offsets. As a general rule offsets should not be longer than about half-an-inch at the scale used to plot the survey.

Chain surveying is best suited for recording irregular detail, especially linear detail such as ditches and banks, which is fairly evenly distributed over the area to be mapped. It is not satisfactory on very broken or steeply-sloping ground, or for the planning of excavations where the surface is obstructed by dumps.

The framework of a *traverse survey* consists of a number of points or 'stations' connected by a continuous path of straight lines, known as the 'legs' of the traverse. The position of the stations is fixed by measuring the length and direction of the legs, and the legs themselves are used as base-lines for measuring offsets to detail, as in chain surveying. Traverse surveying is thus suitable for recording linear detail such as ancient roads and earthworks.

Traverses are of two kinds: a *closed* traverse finishes upon its starting-point; an *open* traverse does not. The stations of the traverse should be chosen so that the legs run as close as possible to the detail which is to be mapped. It is a mistake to try to reduce the number of stations to a minimum in the hope of avoiding errors. The longer are the offsets the greater is the risk of inaccuracy; moreover, the accummulated error in measuring either angles or distances does not increase in simple proportion to the number of measurements made; it is a convenient fact in surveying that the greater the number of measurements made the smaller will be the probable average error per measurement.

The legs of the traverse are chained and offsets to detail taken exactly as in chain surveying; the booking of the measurements also is carried out as before, except that a separate column should be drawn on the left of the page of the field-book, in which the bearings of the traverse legs are recorded. The direction of the legs is best measured with the prismatic compass, which should be used on a tripod or other rest to steady it.

Both the methods of survey already described are designed for mapping linear detail, but neither is well adapted for fixing

the position of isolated points. This is a problem, however, which often arises in archaeological work, as, for instance, in an exploratory survey of a group of newly discovered barrows, or in mapping the trench system of an excavation. Such problems may be solved by the method of *compass triangulation* now to be described.

The method is very simple, being merely an elaboration of Basic Method 3 (p. 89). The only instruments needed are a prismatic compass, preferably with a tripod or rest, a measuring tape, and ranging poles; and for plotting the survey, which should be done in the field, a drawing-board, squared paper, ruler, and protractor.

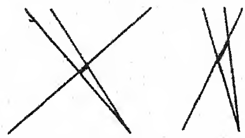


Fig. 36

In its simplest form the method consists of choosing a base-line whose end points are visible from all the points to be fixed, measuring its length and bearing, and then from each end in turn taking and noting the bearings of the points to be fixed. To plot the survey the base-line is drawn at a suitable scale and at the correct bearing, on squared paper, and the other bearings are set off with the protractor from each end, their intersections giving the positions of the points to be mapped.

In practice, however, the method is seldom quite as simple as this, because not all the intersections obtained in this way will be 'good' ones. The importance of good intersections will be understood from Fig. 36. Where two lines intersect almost at right angles, the change in the position of the intersection due to a small angular error in one of the lines is fairly small; but this change increases rapidly as the angle of the intersection becomes more acute or more obtuse. For this reason a point should not be considered as accurately fixed by an intersection whose angle is less than 30° or more than 150°, and it is wiser if possible to keep within the narrower limits of 60° and 120°.

It will thus be clear that only a limited number of points can be fixed by good intersections from the ends of any one base-line, and that it may in consequence be necessary to fix the position of intermediate points to serve as the ends of

additional bases. This is shown in Figs. 37 and 38; in both cases *AB* is the primary measured base, and *C*, *D*, *E*, and *F* the points whose position is required. The remaining points are fixed as intermediate stations from which the final bearings are taken.

In certain cases it may be desirable to reverse the procedure. For instance, if in Fig. 37 the letters *C*, *D*, *E*, and *F* represent the centre points of four barrows which are to be mapped, it will be clear that each of these points must be visited in order

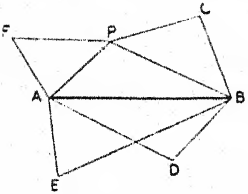


Fig. 37

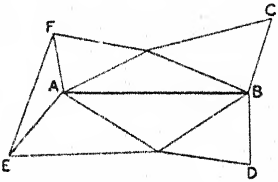


Fig. 38

to obtain details of the size and shape of each barrow. Accordingly the base *AB* is first laid out, and its bearing and length measured. The surveyor then moves to the point *P* and takes bearings from there to *A* and *B*, leaving a mark there before moving on to the barrow at *C*. He notes the measurements of this barrow, and takes bearings to *P* and *B*. The rest of the barrows are also measured and bearings are taken from them to *A*, *B*, or *P* to fix their position. In this way the work can be shortened, especially where there are a large number of points to be fixed, as the taking of bearings from the ends of the base-line *AB* is eliminated.

To plot the map, the bearings are converted to back bearings, and plotted exactly as described above; for it is clear that if the bearings of *A* and *B* from *P* are known, the bearings of *P* from *A* and *B* (i.e. the back bearings of the same lines) are also known.

It should be added here that the base-line *AB* should not be shorter than 3 inches at the scale chosen for the map. If, for instance, the base-line were only 1 inch long, an error in its length equivalent only to a small dot (1/100 inch) would mean

that the scale of the whole survey would be in error by 1 per cent. On the other hand, the same increase in a 3-inch base-line represents an error of only 0·33 per cent, which is reasonable for this type of work.

A compass survey of this kind should always be plotted in the field, in order that any gross errors can be detected and rectified at once. It is always wise, however, to make a record in figures as well, because the first plot may be destroyed or damaged, and because if it is desired later to plot the map at a different scale it is always easier to work from figures than to enlarge or reduce the existing map.

The record in the field-book should take the form of a rough sketch of the points in their relative positions, each point being labelled with a letter (*not* a number, which would lead to confusion), or a brief description. Beneath this are tabulated the bearings and any other necessary notes. For instance, part of the record for the survey shown in Fig. 37 would read as follows:

GROUP OF FOUR BARROWS ON SHEEP DOWN FARM

BEARINGS (magnetic)		
A to *B*	101°	Base-line. Length 200 ft.
P to *A*	238°	
P to *B*	126°	
C to *P*	265°	Barrow at *C*. Round. Diameter 74 ft.
C to *B*	169°	Height, 3 ft. 6 in. No apparent ditch. Unexcavated.

etc., etc.

It will be realized that with an instrument as 'coarse' as the prismatic compass a high degree of accuracy cannot be expected in a survey of this sort; but providing the triangles are chosen with care and the compass is used on a rest or tripod, so that angles can be read to the nearest $\frac{1}{2}°$, the method is quite suitable for all ordinary archaeological purposes, and has the additional advantage that only light portable equipment is needed and the whole survey can be carried out by the solitary worker.

An interesting test of the archaeological surveyor's skill would be to carry out a survey of this kind, first by pacing the

base-line and carrying the compass in the hand, then with a measuring tape and a tripod to steady the compass, and finally, if he has the necessary knowledge and equipment, with a steel tape and a theodolite, the survey in the last case being plotted by calculation and not with the protractor. A comparison of the three plotted surveys and the time taken to complete each will provide a good index of their relative value for archaeological work, and incidentally of the skill of the surveyor.

Plane tabling is one of the most interesting methods of survey, and one which can be of great use to the archaeologist. Its principal advantages are that the survey can be carried out by one person; that the map is constructed in the field as the work proceeds, thus enabling errors to be found and checked at once; and that it is a more rapid method than compass triangulation, and at least as accurate. Its chief disadvantage is the size of the equipment, which it is a nuisance to carry for long distances.

The equipment required for plane tabling consists of the plane table and its tripod, an alidade, a prismatic compass, a measuring tape, and ranging poles. The principle of the method is that given in Basic Method 3 (p. 89), namely, that the position of a point can be fixed by the intersection of two lines of known direction drawn from the ends of a known base-line.

For the normal method of mapping with the plane-table the reader is referred to the books cited in the Bibliography. Brief details are given here of a less orthodox method, which provides one of the quickest means of planning earthworks and other structures of moderate relief. The method requires a plane-table, alidade, compass, and 100 ft. measuring chain or tape, and preferably two assistants for the surveyor.

The plane-table is set up and levelled near the centre of the area, and the direction of magnetic North marked at one edge by means of the compass. A pin is stuck in vertically near the centre of the board, and the rear part of the right-hand edge of the alidade pivoted against it. One assistant takes the zero end of the tape and, starting from the outer edge of the site, moves inwards along a straight line towards the plane-table, stopping successively at each point to be recorded; the second assistant

stands level with the centre of the plane-table and reels in the slack of the tape, calling out the distances at each stopping-place. The surveyor draws a ray along the alidade directed at the first assistant in his starting-position, and notes at the outer end of this ray the figures called out by the second helper. This procedure is repeated along a series of radial lines all round the site. The points to be recorded are then plotted to scale on their respective rays by means of a pair of dividers, or by a suitable scale pivoted upon the central pin. On small sites the whole plan can be completed from one station; on larger ones a number of stations must be chosen, within a chain or tape's length of the furthest detail to be recorded. These stations are best fixed by the intersection of rays from the ends of a measured base-line, in the orthodox way, and marked by pegs. The plane-table is set up over each peg in turn, and the neighbouring detail plotted from it as described above, the table being orientated at each new position by sighting an adjacent station with the alidade laid along the ray joining them. Fig. 39

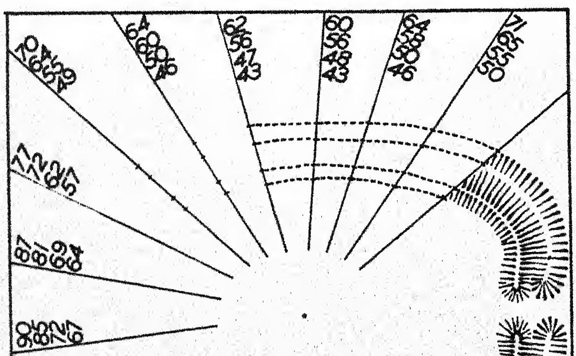


Fig. 39

shows the principle of this method, and three stages of the work; on the left the rays and figures only are recorded; in the centre the points marking the limits of the ditch and bank have been plotted to scale and joined by broken lines; while on the

right the survey has been completed by drawing the appropriate hachures to represent the earthwork.

In the hands of an experienced surveyor aided by an intelligent assistant, more advanced instruments such as the *theodolite* and the *telescopic alidade* enable archaeological sites to be surveyed with speed and accuracy, especially if tacheometric methods of determining distances are used. The employment of such instruments, however, requires special training beyond the scope of this book; further details will be found in the works listed in the Bibliography.

THE PLANNING OF EXCAVATED SITES

The surveying of excavated structures will occupy much time on a dig, but with careful organisation and forethought this can be reduced to a minimum. It cannot be too strongly emphasised that on every excavation where more than two or three cuttings are made, a grid or other regular pattern of numbered reference-pegs should be set out at the start and located on a site plan, and that every cutting should be plotted on the plan *before* it is excavated. If this is not done, and the planning is left to the end of the excavation, the presence of dumps will greatly hinder the surveyor.

In most cases the existence of a suitable network of reference points, already plotted on the plan, will enable the excavated detail to be readily surveyed with a chain or tape alone, each point being fixed by two, or preferably by three, measurements, from different pegs; since the details will be mostly below the level of the pegs, its position must be projected into the plan of the pegs (i.e., the surface level) by the use of a vertical tape weighted at the end (as in Fig. 64).

Where the use of previously located reference pegs is impossible, the method of surveying adopted should be one which avoids linear measurements, since these are likely to be obstructed by dumps; suitable methods, in descending order of accuracy, are triangulation with a theodolite, plane tabling, tacheometric survey with a telescopic alidade, and compass triangulation.

On circular or nearly circular sites, where the detail to be

planned lies around an approximately central point, and the area has been stripped to bedrock, the *radial line* method of planning has been found to be rapid and accurate. A centre-point and a number of other points round the circumference of the site are chosen, marked with pegs, and plotted on the plan by measurements taken from the ends of a suitable base line; in many cases existing reference pegs can be used. A 100 ft. measuring-tape is fixed with its zero end at the centre peg, and is stretched out radially across the site; a second tape is fixed at a suitable reference peg on the circumference, and is stretched to meet the radial tape so that the angle of junction is about 90°. The measurements on both tapes at their junction is noted, and with a vertical weighted tape measurements are then taken at suitable points along the radial line. The latter is then shifted by a few degrees, the new measurements of the point of junction noted, and further radial measurements taken. The

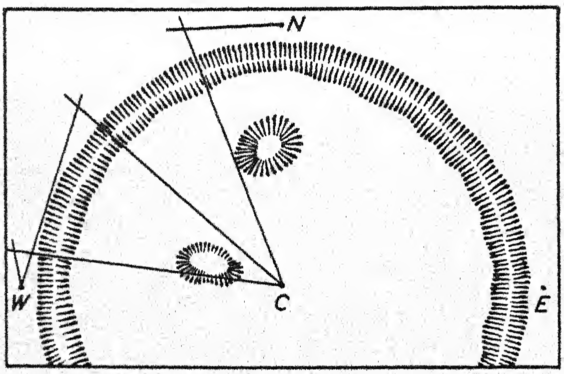


Fig. 40

method is shown in Fig. 40. To simplify matters the position of the junction on the radial tape should be kept constant as far as possible; when the angle of junction of the two tapes falls below 60° or above 120° the check tape should be shifted to another reference peg. The measurements can either be recorded in columns in the notebook, or can be plotted directly on the drawing-board as the work proceeds.

PACING

The use of pacing as a means of measurement has already been mentioned. It is a method which is too often despised, and one which can be of great value provided its limitations are realized.

Two cautions are necessary. First, it needs practice. The amateur surveyor will at first be disappointed with his results when compared with the measurement given by the measuring tape, because in trying to pace exactly one yard his pace will become unnatural and erratic. It is far more satisfactory to aim at a natural easy stride, and to convert paces to feet or yards afterwards by calculation. Secondly, he must beware of reckoning his pace as of constant length over differing slopes and types of ground.

The best way out of both these difficulties is to pace a measured length of not less than 200 yards with an even natural stride, half a dozen times, and find the average number of paces for the distance. If this is repeated over various slopes and types of ground, a number of 'pace factors' can be found, by which paces can be converted to yards or feet. Thus, if it takes 220 paces to cover 200 yards on level ground, all future measurements in paces over level ground must be multiplied by the factor $\frac{200 \times 3}{220}$, or 2·73, to give the distance in feet. These factors should be checked from time to time by repeating the comparison with the measured distance and working them out afresh.

On open, fairly level ground pacing should be accurate to within 2 or 3 per cent; it is therefore quite suitable for exploratory surveys, especially when carried out by a single worker, for whom the frequent use of the measuring tape is impossible. Over rough ground, such as ploughed fields, however, or upon steep slopes, the error is likely to be too great for useful work.

SLOPES

It has already been pointed out (p. 88) that the slope distance between two points not at the same level is always greater than the horizontal distance. In Fig. 41, for instance, the dis-

tance AB will always be greater than the horizontal distance AB', no matter how steep or how gentle the slope of AB. Consequently, if we are to arrive at the horizontal distance, which is what is required for mapping, we must subtract from the measured slope distance a part $B''B$, leaving AB'' which is equal to the horizontal distance AB'. The ratio in which the distance to be subtracted, $B''B$, stands to the slope distance AB varies with the size of the angle BAB', that is, with the slope of AB. A table of the percentage of AB to be *subtracted* for various slopes is given on p. 217 (Table II). Slopes of less than 6° may be ignored, as the distance is too small to be appreciable.

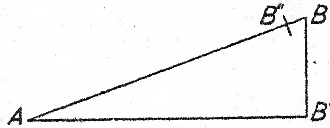


Fig. 41

Conversely, if it is required to set out upon sloping ground two points whose horizontal distance apart is AB', it will be clear that the actual distance to be measured out will be greater than the given distance. In other words, to measure out a horizontal distance AB' we must first lay out on the ground an equivalent distance AB'', and then add to that an extra fraction $B''B$. This fraction also varies with the slope of AB; the percentages to be *added* to the given distance will be found in Table III, p. 217.

It may be useful to give here the trigonometrical relations upon which these tables are based. In any right-angled triangle ABC (Fig. 44), where AB is the known slope distance between two points, AC is the corresponding horizontal distance, and BC is the vertical distance between the same points,
if AB is known,

$$AC = AB \times \cos\phi$$
$$BC = AB \times \sin\phi$$

and if AC is known,

$$AB = AC \times \sec\phi$$
$$BC = AC \times \tan\phi.$$

The reader who is not familiar with these terms is referred to any text-book of Elementary Trigonometry.

THE MEASUREMENT OF HEIGHT

The representation of any piece of ground upon a map requires the measurement of height as well as of horizontal distances. The archaeologist has at his disposal three means of measuring height, namely, the eye, the clinometer, and the level. The clinometer is an instrument which measures angles in the vertical plane, thus enabling heights to be calculated by the trigonometrical formulae given above; the level establishes a horizontal plane with reference to which heights can be measured with a graduated staff.

1. *Measurement by eye.* This is a rough and ready method to be used where no other instruments are available. The observer stands at the top of the slope whose vertical height is to be measured, and moves backwards and downwards until the top of the slope is level with his eyes; at this point he kicks a mark in the ground beside his feet. He then moves down again until the mark is at eye-level, and kicks another mark. This process is continued until the bottom of the slope is reached. The vertical height of the slope is then given by the number of marks multiplied by the eye-height of the observer, *plus* the estimated distance between the lowest mark and the bottom of the slope. This method is suitable only for steep slopes such as the ramparts and ditches of hill-forts, as the accuracy of the eye in judging a level line decreases rapidly with the decrease in the angle of slope.

2. *Measurement by clinometer.* The following method is suitable for finding the difference in height between two isolated points, such as the bottom and top of a bank, but it is too tedious to use in finding the heights of large numbers of points for the purpose of drawing contours or profiles.

In Fig. 42 A and B are two points on a slope, and ϕ, ϕ' the angles of elevation and depression read from A and B respectively, with reference to the horizontal lines AC and BC'. It should be noted that these angles are equal. Using the formulae given on p. 118, we have the equations

$$BC = AB \times \sin \phi,$$
$$\text{and } AC' = AB \times \sin \phi'.$$

In actual practice the readings with the clinometer would not be taken from A and B, which are points on the ground,

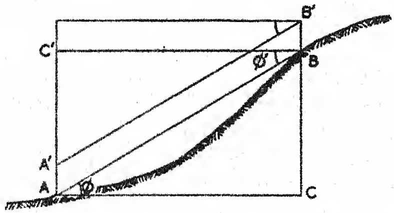


Fig. 42

but from A' and B', at the surveyor's eye-height above A and B; and in order that the line of sight shall be parallel to the line AB, the reading at A' is taken to a point B' at eye-height above B, and vice versa.

Hence we may formulate the following rule: *To find the difference in height between two points, multiply the slope distance between them by the sine of the angle of elevation or depression.* The latter must be looked up in a set of Trigonometrical Tables.

A variant of this method may be used to find the height of barrows and other earthworks during rapid surveys in the field. The surveyor pins the zero end of a measuring tape into the ground on the level surface; he then walks to the point whose height is to be measured and pulls the tape taut, taking the reading at the level of his eyes. Then, without moving, he sights the clinometer on the pin holding the end of the tape, and reads off the angle of depression, which he finds to be $\phi°$. He multiplies the reading of the tape by the sine of this angle to find the height of his eyes above the level ground, and subtracts his eye-height from this figure to find the height of the barrow (Fig. 43).

If the *horizontal* distance between two points A and B (Fig. 44) is read off from a map, instead of the slope distance being measured on the ground, we have the equations

$$BC = AC \times \tan \phi,$$
$$\text{and } AC' = BC' \times \tan \phi'.$$

Hence we can formulate a second rule: *To find the difference*

in height between two points, multiply the horizontal distance between them by the tangent of the angle of elevation or depression.

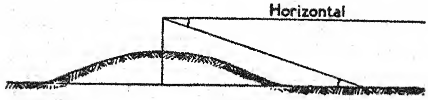


Fig. 43

Where a height is required in the field and trigonometrical tables are not available, the following formula may be used:

$$H = \frac{\text{Angle (in degrees)} \times \text{Distance (slope or horizontal)}}{57{\cdot}3}$$

This gives satisfactory results for angles of elevation or depression up to 10°. With larger angles there is an appreciable error.

3. *Measurement of height with the staff and level.* These instruments are used for plotting the contours and profiles of

Fig. 44

earthworks, and for setting up horizontal datum-lines for drawing sections (p. 121). The level consists essentially of a sighting-tube fitted with a horizontal cross-hair which can be set up with the help of an attached spirit-level to give a horizontal line of sight. The staff is a strip of wood or other material, graduated in suitable divisions, which is held vertically on the ground in front of the level. The surveyor looks through the level (Fig. 45) and reads the figure on the staff which is cut by the cross-hair. The reading at *B* is 4·6 feet; the line of sight is therefore 4·6 feet *above* the ground at *B*. The reading at *A* is 2·2 feet; *A* is therefore 2·2 feet *below* the line of sight, or 2·4 feet *above B*. If this simple principle is understood, the

reader should have no difficulty in following the example of levelling given below. It should be noted that for archaeological work the staff need only be read to the nearest 0·1 foot.

It is required to plot the profile of a rampart and ditch from *A* to *I* (Fig. 46). A large peg or a flat stone is sunk into the ground at *A*, so that its top is at ground-level. This point is given the arbitrary height of 100 feet. The level is then set at *O* and a reading taken on the staff, which is held by an assistant at *A*. This reading is found to be 5·0 feet. The height of the

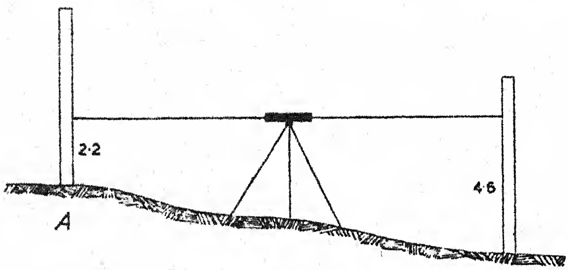


Fig. 45

line of sight, or to give it its proper name, the line of collimation, is therefore 105 feet. The staff is now moved to the first of a line of pegs *B*, *C*, *D*, etc., which have previously been set in the ground at roughly equal intervals along the line of the profile.

At *B* the reading is taken from the same level station *O*, and is found to be 5·8 feet. *B* is therefore 5·8 feet below the line of collimation, and its reduced level (i.e. its height relative to *A*) is 105—5·8=99·2 feet.

At *C* the reading is 1·2 feet; the height of *C* is therefore 103·8 feet. It now becomes clear that *D* is above the line of collimation, and that therefore no reading can be taken from the staff in its present position. Accordingly the level is moved to *P*, and from this position a second reading is taken to the staff at *C*. This reading is found to be 2·5 feet; the new line of collimation is therefore 2·5 feet above *C*, and its height is 106·3 feet.

Readings are now taken in turn on the staff at *D* and *E*; and it is estimated that at *F* the reading would be off the staff. Accordingly the level is moved to *Q*, and a second reading taken to the staff at *E*. This process is repeated until the end of the line is reached, with the staff at *I*.

The staff stations to which two readings are taken from successive positions of the level (*C*, *E*, *F*, and *G* in Fig. 46) are known as *turning-points* (abbreviated T.P.). The reading to a turning-point from the *previous* level station is known as a *foresight*, and that from the *next* level station as a *backsight*; the first reading taken is also always a backsight (*OA* in Fig. 46), and the last reading always a foresight (*SI* in Fig. 46). Staff stations which are neither foresights nor backsights are called *intermediates*. The level stations may be chosen anywhere, and need not be on the actual line of the profile, but it is wise when using the Abney level (p. 127) to set it up so that it is equi-distant from the nearest two turning-points, in order that errors due to faulty setting of the index may be eliminated.

When levelling in the field, only the actual readings are noted, the reduced levels being calculated and plotted at home. The readings may be noted in several ways; a simple method is given in Fig. 47, using the figures for the profile already described. Columns 1–4 and 7 are filled up in the field, the remainder at home. As a check on the figures, the difference of the sums of the backsights and foresights should be calculated; if no errors have been made this difference should be equal to the difference in level between the starting- and finishing-points of the line.

The distances of the staff stations from the starting-point, which are recorded in column 7, should be measured horizontally. The measuring tape is held out taut and horizontal, and a plumb-line is dropped on each point in turn.

The profile is plotted on squared paper exactly like a graph, the separate points being joined by a smooth line. The practice of exaggerating the vertical scale in order to emphasize details of the relief is *not* recommended for archaeological work, except in special cases.

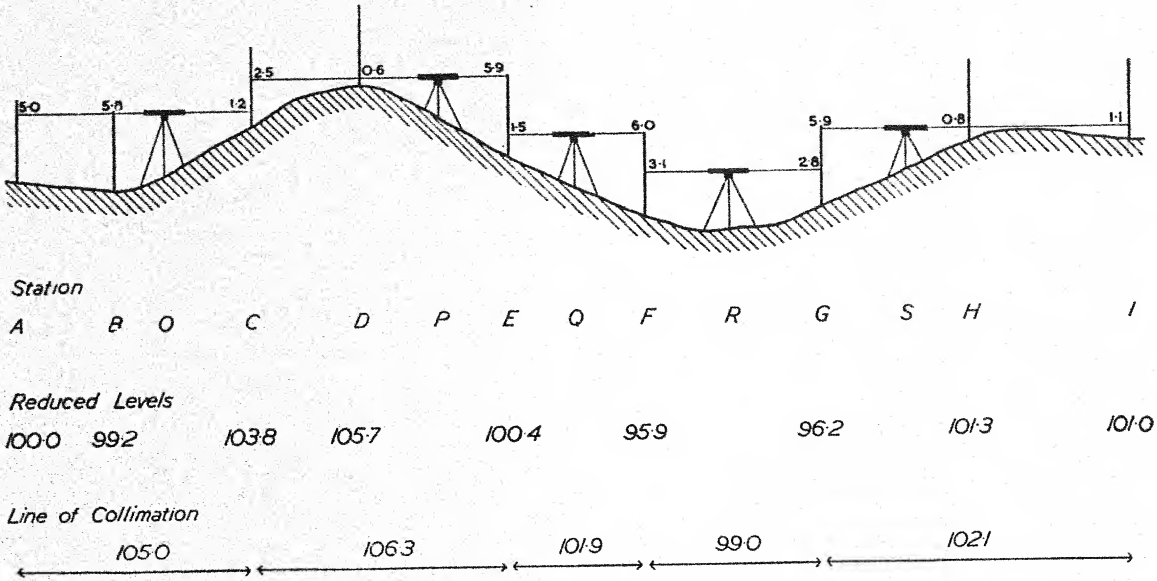

5·0
5·8
1·2
2·5
0·6
5·9
1·5
6·0
3·1
2·8
5·9
0·8
1·1
Station
A B O C D P E Q F R G S H I
Reduced Levels
100·0 99·2 103·8 105·7 100·4 95·9 96·2 101·3 101·0
Line of Collimation
105·0 106·3 101·9 99·0 102·1

Fig. 46

CONTOURING BARROWS

For this purpose a slightly different method of levelling is used. The highest point of the barrow is marked with a peg, and other pegs are driven into the level ground some yards outside the barrow, at points from which there is a clear line of sight to the centre. These points should be at equal intervals round the circumference, as far as obstructions to the line of sight

Station	Foresight	Intermediate	Backsight	Line of Collimation	Reduced Level	Distance	Remarks
A			5·0	105·0	100·0	0	Reference peg K9
B		5·8		105·0	99·2	7	Tail of rampart
C	1·2		2·5	105·0	103·8	17	
D		0·6		106·3	105·7	25	Crest of rampart
E	5·9		1·5	106·3	100·4	36	
F	6·0		3·1	101·9	95·9	46	
G	2·8		5·9	99·0	96·2	59	
H		0·8		102·1	101·3	70	
I	1·1			102·1	101·0	82	Tail of counterscarp

17·0 18·0 A – I

Difference 1·0 Difference 1·0

Fig. 47

allow. Their number depends upon the regularity of the surface of the barrow. If it is smooth and even, eight such points will be enough; if it is very broken and irregular, twelve or sixteen will be necessary. These points are numbered, and their bearings from the central peg measured with the prismatic compass and noted.

The end of a measuring tape is now fixed to the central peg, and the tape stretched along the ground to one of the outside pegs. The level is then set up over the centre point, and its height above the ground measured by bringing the staff right up to it. The surveyor should then decide at what vertical interval he wishes to plot the contours; for large barrows a vertical interval of 1 foot should be sufficient, and for smaller ones 6 inches. In some cases, where the relief of the surface is very slight indeed, a vertical interval of 0·1 foot may be necessary; for this an engineer's or Dumpy level should be used, as the smaller Abney level is not sufficiently accurate.

Having decided upon the vertical interval and having measured the height of the level above the centre point, the surveyor now directs an assistant to move backwards with the staff down the slope of the barrow, setting down the staff for a reading at short intervals along the tape. At the point where the reading is greater than the height of the level by the vertical interval the surveyor calls a halt, and the assistant places a peg in the ground. A second peg is put in a foot lower (or whatever the vertical interval happens to be), where the reading is greater than the height of the level by *twice* the vertical interval. This process continues until the end of the tape is reached, on level ground some yards outside the barrow. To prevent mistakes, the pegs should have written on them the height which they represent. Thus, if the vertical interval chosen is 1 foot, the first peg will be marked —1 foot, the second —2 feet, and so on.

Should the barrow be very tall, it may be necessary to take a turning-point on the slope, and set up the level outside the barrow to complete the line of points. If this is done, the height of the level must be measured afresh when the instrument is again set up over the central point.

When marked pegs have been placed on all the radial lines, the *horizontal* distance of each peg from the centre should be measured and noted. This should be done by holding the tape horizontally and dropping a plumb-line on to each peg in turn.

To plot the contours, the radial lines are drawn at the correct bearings. The distance of each peg from the centre is then measured off along the appropriate line, and its height marked.

All points of the same height are then joined by a smooth line, and the radial lines can be rubbed out. It is important that the vertical interval should be expressed, either by numbering the contours or by marking on the plan 'V.I. = — feet'.

Whenever possible such contour surveys should be plotted in the field, in order that any errors may be corrected on the spot.

CONTOURING ON A GRID

The foregoing method of radial contouring is suitable only for round barrows and other earthworks which are more or less symmetrical about a central point. It may often be necessary, however, to contour a larger and more irregular area of ground, in order, for instance, to plot accurately the form of a ploughed-down earthwork whose boundaries cannot be fixed by eye alone.

For this purpose a grid of points is set out by either of the methods described on p. 95. The level is then set up at any convenient station, and readings are taken to as many points on the grid as possible, a turning-point being taken and the level set up at a new station when necessary. In order to avoid omitting or repeating readings at any point, the surveyor should have with him in the field a rough chart of the grid, on which the reading of each point is written in the correct position as it is taken; turning-points should be clearly indicated, and all the readings taken from the same level station should be enclosed by a line (Fig. 48).

INTERPOLATING CONTOURS

So far the surveyor has found only a number of spot-heights, many of which will not lie exactly on the contours which he wishes to draw. Accordingly, the positions of the actual contours must be found by interpolation.

The first step is to reduce all the readings on the grid to their real heights, calculated with reference either to a bench-mark or to a temporary point which is given the arbitrary height of 100 feet (Fig. 49). Next, the vertical interval should be chosen; it should be small enough to bring out clearly the smallest rise and fall that is likely to be of significance. In the present

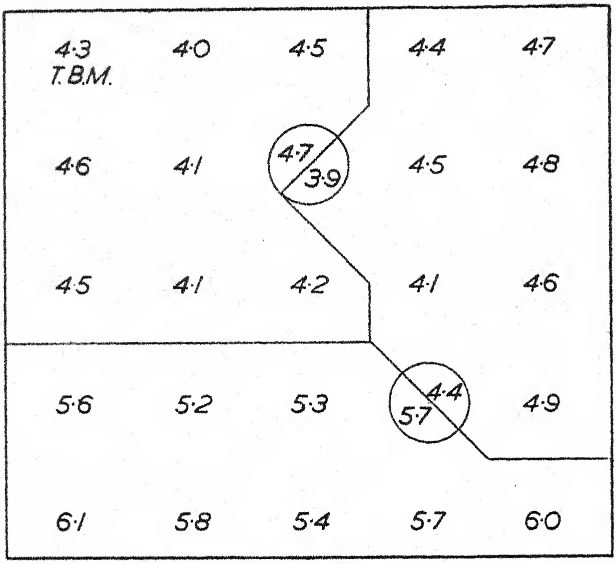


Fig. 48

100·0	100·3	99·8	99·1	98·8
99·7	100·2	99·6	99·0	98·7
99·8	100·2	100·1	99·4	98·9
99·2	99·6	99·5	99·1	98·6
98·7	99·0	99·4	99·1	98·8

Fig. 49

instance the earthwork which was contoured was a much-flattened round barrow, the greatest rise and fall being about 2 feet. The vertical interval chosen was 0·5 foot (Fig. 50).

The simplest method of interpolating contours is to take each line of points in turn, first across the grid and then up

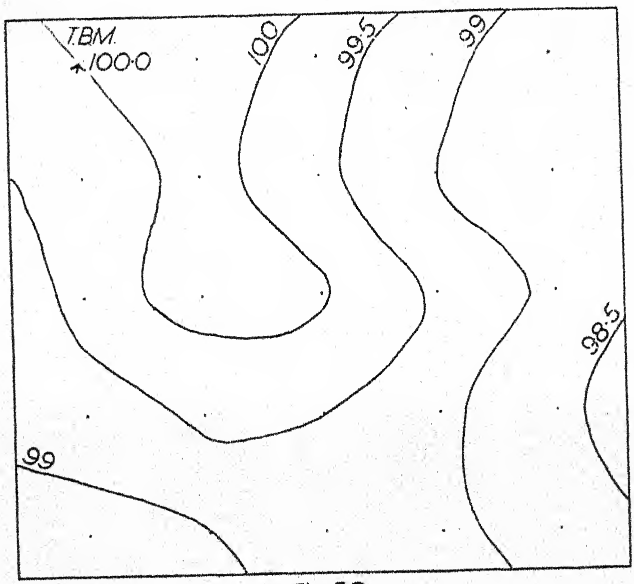


Fig. 50

and down it, and plot the section of the line on squared paper. The horizontal scale of the section should be the same as that of the plotted grid, but the vertical scale may be exaggerated if desired. The horizontal lines of the squared paper which represent the various contour-heights are now followed along to the points where they cut the section, and perpendiculars are dropped from these points to the base-line (Fig. 51). The paper is now folded along the base-line and placed in position on the plotted grid, so that the feet of the perpendiculars can be transferred to the appropriate line. When all the necessary points have been interpolated in this manner, all those of the

same height should be joined together by a smooth contour-line (Fig. 50).

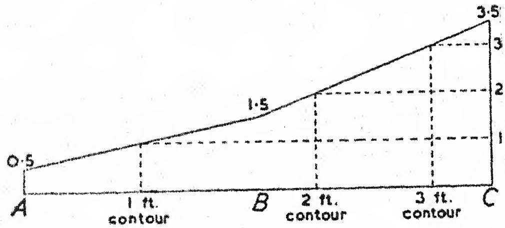


Fig. 51

DRAWING SECTIONS

In archaeological work a section is any vertical exposure of the strata of a site. The recording of sections in measured drawings is the principal method of showing diagrammatically the history of the site, and is therefore one of the most important operations to be carried out in the field, and one in which accuracy is essential.

The object of drawing sections is to record in their correct positions all the exposed layers. It is essential, therefore, first to decide exactly where the boundaries between them lie. To do this is not always easy, as the layers will often appear to merge gradually into each other with no sharp line of division. In such cases it is often helpful to look at the section upside-down (standing, that is, with the back to the section and bending down to look through the legs); from this unaccustomed position it is frequently possible to notice details not apparent to the normal view. Where the line of junction between two layers is not clearly marked already, it should be lightly outlined on the side of the cutting with the point of a trowel.

The next step is to set up a datum-line, in the form of a horizontal string stretched taut from side to side of the section. A measuring tape is laid out alongside the string, and the shape of the layers can then be plotted from measurements taken along the tape and above and below the datum-line. There are two possible methods of setting up a horizontal datum-line.

1. *With staff and level.* A peg or arrow is driven into the side of the trench horizontally at one end of the section to be recorded. The staff is held vertically with its foot resting on the peg, and the reading is taken with the level. The staff is then carried to the other end of the section, and is slowly lowered down the side of the cutting until the same reading is seen through the level. A second peg is then driven in horizontally at the foot of the staff, and the line joining the two pegs will be horizontal. On long sections one or more intermediate pegs should be fixed by the same method. A strong string is then stretched over these pegs, drawn taut, and fastened at the ends. The measuring tape may be conveniently anchored to the same pegs by spring clothes-pegs, but it should not be twisted round them to secure it, as such treatment is likely to tear it, especially if it is new.

2. *With the spirit-level.* A peg is placed in the side at one end of the section as before. A long straight piece of wood (a ranging pole will do, but a longer pole is preferable) is rested on this peg at its left-hand end; the surveyor supports the right-hand end of the pole on a second peg held in his right hand, and with his left holds a spirit-level on the upper surface of the pole. The right hand is gently lowered until the pole is horizontal, and the second peg is driven into the side of the cutting. The process is then repeated, resting the left-hand end of the pole on the second peg. A line of pegs is thus set up right across the section. This method is not as accurate as the former, as any small error in the spirit-level accumulates each time the process is repeated. The accuracy of the level can be checked by reversing the level each time and noting any difference. Except in the most accurate work the string may be dispensed with, the tape itself acting as the horizontal datum. In this case the supporting pegs must not be more than about 5 feet apart, in order to prevent the tape sagging.

The string or tape should be so arranged that it is as close as possible to the section, without actually touching it, and care should be taken to avoid roots and other projections which might hold it out of true level.

In many cases it may be necessary to set up datum-lines at

more than one level, in order to cover the full length of the section (e.g. Fig. 52, where a separate datum-line has been set up for the ditch section, and another over the unexcavated portion). When this is done the vertical interval between the lines must be carefully measured and recorded, and it will facilitate plotting the section if the interval is a simple multiple or fraction of 1 foot.

Once the datum-line has been set up the measurement of the section can be started. At equal intervals along the tape the distances above and below the datum of the various layer-

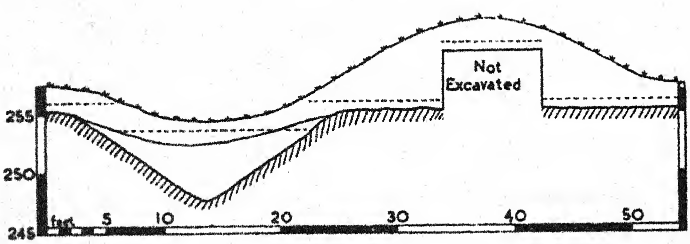


Fig. 52

junctions are measured and noted. These vertical measurements can be made with a 6-foot steel measuring tape; a more accurate method is to use a 33-foot linen tape, which has a lead or brass plumb-bob fixed at the zero end in place of the usual brass swivel; this will ensure that all the measurements are vertical.

The method of recording the measurements is shown in Fig. 53. The intervals along the datum-line at which measurements are made are written at the top of the page, and the appropriate vertical measurements below them. On the left-hand side is written a description of each layer, and also whether it is the top or bottom of the layer that the measurements refer to. Space should be left for the insertion in brackets of any special readings which may be taken to fix the exact end of a layer.

The intervals along the datum-line at which readings are to be taken depend upon the amount of variation in the section; usually 1 foot is the smallest interval, and where there is little

0	5	10	15	20	25	30	35	40	45	50
Surface										
1′ 6″	7″	1′ 1″	10″	1′ 10″	2′ 2″	4′ 9″	1′ 8″	1′ 7″	4′ 7″	2′ 5″
Surface of old silting										
(2′ 6″)					(24′ 6″)					
1′ 2″	2′	11″	11″	0″	1′ 2″					
Natural rock										
			(13′ 6″)							
8″	2′ 9″	4′	5′ 10″	2′	1′	9″	9″	9″	8″	9″

Datum Lines

0″–5′ 9″	256′ O.D.
5′ 9″–22′ 6″	254′ O.D.
22′ 6″–33′ 9″	256′ O.D.
33′ 9″–42′ 3″	261′ O.D.
42′ 3″–54′ 0″	256′ O.D.

N.B Partially excavated only from 33′ 9″ to 42′ 3″.

Fig. 53

detail to be shown 3 feet or even 5 feet will be sufficient. It must be realized that however regularly the layers have been deposited, no two sections, even when close together, will have exactly the same appearance. A drawn section is in a sense an abstraction, and the small irregularities in the junctions of the layers are therefore irrelevant; the important thing to be recorded is the general character of the arrangement of the layers.

The measurements are plotted exactly like a series of graphs, on squared paper. It should be noted that for archaeological work the vertical and horizontal scales should be the same, though it is occasionally useful to exaggerate the vertical scale in order to bring out small details of stratification. If this is done, the exaggeration *must* be pronounced and unmistakable, and a true-to-scale section must always be included for comparative purposes.

It is desirable that the section should be plotted at once in the field, so that errors can be detected and rectified. When

the drawing and figures are complete, the following information should be added to both records:

1. Name of the site.
2. Exact position of the section (e.g. *E. side, Trial Trench A2*).
3. The layer numbers (p. 146). Each number should be written in a circle in its proper layer.
4. A short description of each layer.
5. The scale of the section.
6. The reference numbers (i.e. pottery bag numbers and small find numbers (pp. 141, 143) of the finds from the cutting of which the section forms one side.
7. The date, and the names of the persons responsible for measuring and drawing the section.

The duplication of the record may seem unnecessary, and many workers dispense with recording the figures and plot the drawing direct from the observed measurements. The double record, in two different places, however, provides a safeguard against the loss or damage of either part; also, if the section is to be re-drawn for publication at a different scale, it will be found easier to work from the figures than to enlarge or reduce the existing drawing.

PLANS, SECTIONS, AND SCALES

The most convenient scales for use in archaeological field-work fall into two groups, which are based on the most common divisions of squared paper, namely, into inches and tenths and inches and eighths. Thus the former group comprises scales such as 1 *inch* to 5 *feet*, 10 *feet*, 50 *feet*, 100 *feet*, etc., and the second such scales as 1 *inch* to 4 *feet*, 8 *feet*, 16 *feet*, 32 *feet*, etc. The following list is given as a general guide to the various types of plan and section to be drawn on a site, and to the scales most suitable for each type:

1. ***Map showing the relation of the site to the surrounding country.***

   This can be based on the existing Ordnance Survey maps at the 25-*inch*, 6-*inch*, or 2½-*inch* scales, or on

reductions from them. The position of the main plan can also be further defined by an inset on the 1-*inch* scale, covering a wider area, and this in turn, if necessary, can be defined on a second inset on a much smaller scale.

2. *Site plans showing all the structural finds.*

   For this purpose scales from 1 *inch* to 50 *feet* to 1 *inch to* 5 *feet* should be used, as circumstances dictate. The scale chosen should be sufficient to show clearly and accurately the smallest relevant detail, unless still more detailed plans at a larger scale are also drawn.

3. *Detailed plans of structural finds.*

   For showing small detail 1 *inch to* 5 *feet* should be the smallest scale used. Very small detail, such as grave-goods *in situ*, should be drawn at a quarter, half, or even full size.

4. *Sections of cuttings, pits, and ditches.*

   The scale chosen must be adequate to show clearly the details of the stratification in the *vertical* plane. If too small a scale is chosen the vertical detail will be cramped into a space too small for accurate drawing. Hence, except in the case of very deep and narrow ditches and pits, 1 *inch to* 2 *feet* should be the smallest scale used.

5. *Surface profiles of earthworks which have not been excavated.*

   In these cases there is little detail to be shown, and smaller scales, such as 1 *inch to* 8 *feet*, can be used.

It should be understood that the scales suggested are for use *in the field only*, and are not necessarily for drawings published in a printed report.

FINISHING WORKING DRAWINGS

Drawings made in the field will normally be executed in pencil on squared paper. The detail may be inked in, *with indian ink*, and should certainly be so if the drawings are to be much handled. This should only be done, however, when it is certain that no more additions or alterations are to be made. The edges of the paper may be bound with gummed paper or adhesive tape to prevent tearing.

Sections may be shaded with various hatchings to distinguish

the layers, or, better still, with coloured crayons. All features on plans and sections should be clearly and neatly named, and every sheet should bear the description of the drawing, the scale, the direction of True North, the date, and the names of the persons responsible for the measurements and the plotting.

THE METRIC AND ENGLISH SYSTEMS OF MEASUREMENT

The uniform decimal system of continental usage has certain advantages in surveying, particularly in advanced work involving much calculation; there is little to be gained, however, from the adoption of this unfamiliar system in archaeological work in this country, especially since the results must be published in English units. There is something to be said, however, for the practice of marking plans and maps with additional scales of metres and kilometres, if only as a courtesy to Continental readers.

A decimal system occurs in two cases in English surveying practice. The land surveyor's or Gunter's chain of 66 feet is divided into 100 links, and 10 square chains equal 1 acre; this system facilitates the rapid calculation of areas necessary in cadastral work. A decimal division of the foot into tenths and hundredths is commonly used for the measurement of heights, and the standard (Sopwith) levelling staff is graduated in this way. A case could be made out for uniformity of horizontal and vertical measurements through the use of similarly divided measuring tapes, and such tapes are actually used by at least one archaeologist in this country. In practice, however, the use of different systems for vertical and horizontal measurements causes very little trouble, and the cost of purchasing decimal tapes made to order is hardly justified.

SURVEYING INSTRUMENTS AND EQUIPMENT

Abney Clinometer (Fig. 54). The instrument consists of a sighting tube fitted with a pin-hole aperture, some 4½ inches

long; some models have a telescopic extension to increase the sight-base. At the far end of the tube is a small mirror at 45°, covering half the line of sight, and beside it is a horizontal hair-line. Through a small window in the upper side of the

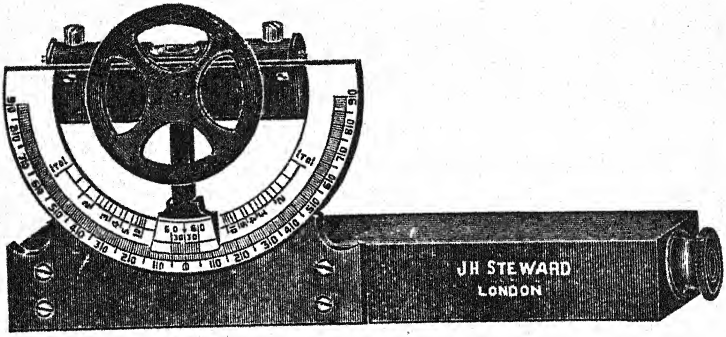


Fig. 54

tube the mirror reflects the image of a small spirit-level fixed above it. The bubble-tube is attached to a pointer ending in a vernier (q.v.) which moves on a semicircular arc graduated in degrees, which is fixed vertically to the side of the tube. The bubble-tube and pointer can be moved by means of a knob or worm-gear.

To read an angle of elevation or depression the surveyor sights through the pin-hole and directs the tube so that the hair-line cuts the object whose height is required. While sighting the object, the knob is turned until the image of the bubble is seen in the mirror exactly opposite the hair-line. The required angle may then be read off from the graduated scale.

To use the instrument as a level, the index of the vernier is carefully set to 0° on the graduated scale. The instrument is then rested on a stick or other support at eye-height, and the stick is swung backwards or forwards until the bubble is seen in the mirror exactly opposite the hair-line. The line of sight is then horizontal.

To test the accuracy of the instrument, two points of differing height should be chosen some distance apart. Each point is sighted from the other, and the angle of elevation and depression found. If these two angles are equal, the instrument is accurate; if not, the error will be half the difference of the two angles.

Alidade. A stout boxwood ruler, usually 14 inches long, with straight bevelled edges. At either end is a hinged metal sighting vane, which can be opened out perpendicular to the base of the ruler; one vane is fitted with a sighting slit, the other carries a vertical hair-line. The line of sight through the slit to the hair-line is parallel to the edges of the ruler. Between the tops of the vanes is a thread which is drawn taut when the vanes are open; this takes the place of the hair-line for very oblique upward sights (Fig. 57).

Arrows. Surveyors' arrows are pins of thick wire some 15 inches long. At the top is a loop, to which is bound a piece of red material, in order to render the arrow more easily visible on the ground. The amateur may easily improvise his own arrows from metal meat-skewers tied with red ribbon at the top. Arrows are used to mark staff and level stations and other fixed points in a survey, and for securing and supporting measuring tapes and datum-lines.

Beam Compasses. The beam compass consists of a rigid rod with a pin pivot at one end and a sliding clamp holding a pencil. The instrument is used to strike arcs which are too long to be covered by an ordinary pair of drawing-compasses.

Chains. The surveyor's chain consists of 100 straight links of steel, marked by brass tags at every tenth link. The length of the surveyor's, or Gunter, chain is 66 feet, and that of the engineer's chain 100 feet, each being divided into 100 parts called links; the latter pattern is preferable for archaeological work. On many sites the use of a chain is unnecessary, since a 100-foot tape will serve equally well, and is lighter and more compact to carry. On upland sites, however, a chain is essential, as the constant wind blows the light tape about too much.

Clinometer. See *Abney Clinometer.*

Compass (Magnetic). See *Prismatic Compass.*

Cross-staff. In its simplest form this instrument consists of

an equal-armed metal cross, mounted horizontally on a socket which fits over the end of a pole at eye-height. The ends of the arms are turned upwards to form vertical vanes; these are provided with sighting slits, so arranged that the lines of sight between opposite pairs of vanes cross at right angles. The lower end of the supporting pole should be shod with a metal point, so that it can be fixed in the ground.

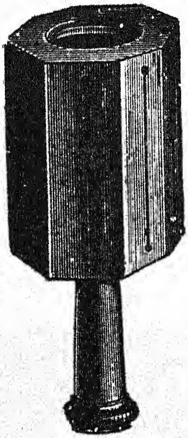


Fig. 55

In use the arms of the head must be horizontal and the pole vertical. To ensure this a metal ring about twice the diameter of the pole should be passed over it, and suspended from the head by three threads of equal length, so that it hangs about half-way down the pole. The pole will then be vertical when it stands centrally inside the ring.

Another type of cross-staff head (Fig. 55) has an octagonal brass body pierced with eight sighting-slits. These enable lines to be set out at 45° as well as at 90°.

Drawing-board. Any piece of flat board may be used for drawing in the field, but it is better to have a special board made for the purpose, with an ebony straight-edge and properly squared corners. The most convenient size is the 'Medium', which just accommodates a sheet of squared paper.

Level. See *Abney Clinometer.*

Levelling Staff (Fig. 56). The professional surveyor's levelling staff (the 'Sopwith' type) consists of three hollow wooden rods sliding into each other, and capable of being extended to a total length of 14 feet. It is graduated in alternate black and white

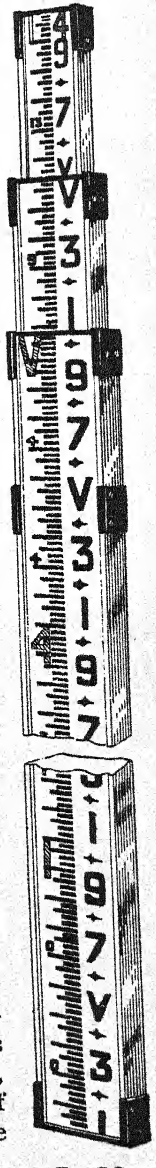


Fig. 56

divisions, each measuring 1/100th of a foot, and is marked in red at every foot and every odd tenth of a foot. A more portable staff may be obtained, consisting of a strip of flexible rubber compound, 6 feet long and 3 inches wide, graduated in the same way. In use the foot is placed on a brass plate at the bottom of the strip, and the strip is stretched out vertically by the hand holding a brass loop at the top.

Since the archaeologist will seldom need to take readings closer than to the nearest tenth of a foot, the use of the Sopwith staff with its somewhat complicated system of graduations is not recommended. A more simple substitute may easily be made from two strips of wood 3 inches wide and 6 feet long, hinged or bolted together so that they can be extended full length when necessary. This staff should be marked off in bands 1 foot long, each painted throughout in a different colour, and further divisions should be marked by a thin black line every fifth of a foot. It should be possible to read to the nearest tenth of a foot on this staff with the Abney level at a distance of 150 feet.

For very rough levelling work an ordinary ranging pole may be used, marked with additional divisions at every quarter foot.

Measuring Tapes. These are made of stout woven material impregnated with paint; they are marked on one side in feet and inches and on the other in links. The tape winds into and is permanently secured to a leather or plastic case. The usual lengths are 100 feet (one Long or Engineer's chain), 66 feet (one Short or Gunter's chain), and 33 feet. A tape 200 feet long, graduated on both sides in feet and inches, is obtainable from Messrs. Brunnings, Ltd., of High Holborn, London W.C.1.

All tapes will stretch gradually with use, and should be checked from time to time against a standard measure (e.g. those on the north side of Trafalgar Square in London); any errors thus detected should be noted and corrected in future measurements.

A new tape is brittle, and will tear if it is twisted tightly round a peg; it will become more supple with use. Tapes should not be dragged along the ground more than is necessary,

especially in wet weather; they should be allowed to dry before they are rolled up and put away.

It should be remembered that the zero point on the tape is the end of the terminal brass loop or swivel, not the end of the material.

Measuring tapes in the form of a flexible steel band are also used by professional surveyors; their chief advantages are accuracy of graduation and constant length. For archaeological purposes, however, these advantages are outweighed by their liability to snap under a sudden strain, and their lack of portability and flexibility when compared with the linen tape.

Optical Square. This instrument, like the cross-staff (q.v.), is designed for setting out right angles. It is lighter and more portable than the latter instrument, but must be treated with greater care, as it has a glass optical system. It may be used in the hand, but should for preference be rested on a staff or tripod.

In its original form the optical square consists of a circular brass box about 2 inches in diameter and $\frac{5}{8}$ inch deep. The sides are pierced by a pin-hole sighting aperture and two rectangular apertures, one diametrically opposite the pin-hole and the other on the right side at right angles to this diameter. Inside the box are two mirrors: one, known as the object-glass, lies across the diametrical line of sight and has the upper half only silvered, the lower half being clear glass; the other mirror, called the index-glass, is silvered all over. The two mirrors are inclined to each other and to the line of sight in such a way that the observer, looking through the pin-hole and the lower portion of the object-glass, sees reflected in the upper portion an image of the index-glass, which in turn reflects what lies on his right perpendicularly to the line of sight. To obtain a perpendicular line to the left, the instrument is turned over and used upside down.

Plane Table (Fig. 57). The plane table consists of two parts, the tripod and the top. The tripod is made either with solid one-piece legs or with lighter legs which fold into three; the latter pattern is preferable for archaeological work. The legs meet at the top in a circular wooden plate covered in baize or felt, which forms the pivot and support for the top.

The top is a flat drawing-board fitted on the under-side with a device for attaching it to the tripod; when mounted on the tripod it is free to rotate in the horizontal plane, but can be clamped fast in any position by means of a central or radial screw. The most convenient size of top measures 24 inches by

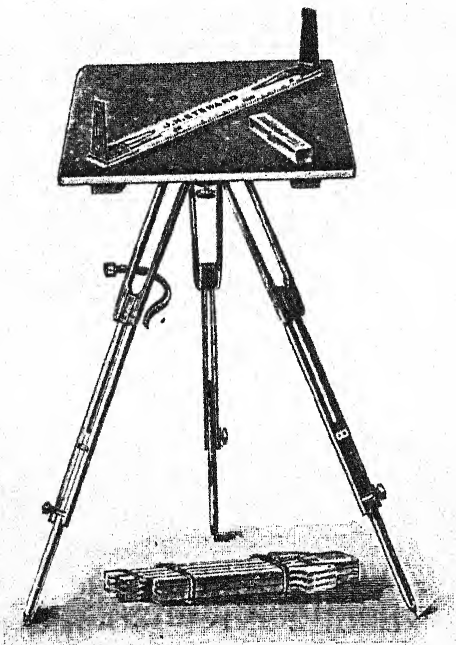


Fig 57

19 inches, which will just accommodate a sheet of squared or cartridge paper.

The paper should be fastened to the top with adhesive paper or tape at the corners; drawing-pins should never be used, as they interfere with the movements of the alidade.

Prismatic Compass (Fig. 58). The prismatic compass consists of a circular brass box with a glass top, containing a round card which swings on a central pivot. The card is graduated in 360°

and has a magnetic needle fixed to its under-side. Hinged to the side of the box is a metal cover containing a glass window, on which a fine hair-line is engraved. At the opposite side of the box is a hinged prism with a slit eyepiece, and below it is a thumb-ring for holding the compass.

Fig. 58

To read a bearing in the hand the cover is raised at right angles, so that the hair-line is vertical, and the prism is swung over so that the slit is also vertical; the thumb is slipped through the ring, the fingers grasping the body of the box. The instrument is then brought up to the eye, so that the hair-line can be seen through the slit. The observer then turns until the object to be sighted can be seen cut by the hair-line; at the same time the prism reflects back to the eye the graduations on the compass card, so that object, hair-line, and reading are all in a vertical line together. The card should be allowed to swing freely until it comes to rest, when the required bearing will be visible,

Some compasses are fitted with a small stop-button, which if gently pressed with the fingers will check the motion of the card and reduce the time taken for it to come to rest.

It will be found difficult to read bearings closer than 1° with

the compass held in the hand, as it is seldom possible to allow the card to come absolutely to rest. For this reason bearings should be taken whenever possible with the compass resting on a tripod (the legs of the plane table do very well) or on a stick at eye-level. In this way bearings can be read to the nearest $\frac{1}{2}°$ with accuracy.

A good compass card should swing for at least 30 seconds before coming to rest. If a shorter time is taken, either the needle has become de-magnetized, or the central bearing is clogged with dirt, or the pivot on which it hangs needs sharpening. To test the magnet, approach a steel knife blade to the compass; if the card shows no movement towards it, the needle requires re-magnetizing.

As explained on p. 209, the north indicated by the compass is not True North, but differs from True North by an angle known as the *variation* of the compass. The variation is not constant at all places and times, and is compounded in part of the magnetic attraction of the earth, and in part of errors and maladjustments of the compass itself.

The best way of determining the variation of a compass is to take the bearing of a True North-and-South line. A piece of smooth level ground is chosen, well away from sources of local attraction such as iron fences and buried water-pipes, and with the help of a plumb-line a thin straight pole is set up vertically on a sunny day. About an hour before noon (1 p.m. British Summer Time, 2 p.m. British Double Summer Time) the end of the shadow cast by the pole is marked, and an arc is drawn on the ground round the north side of the pole, with the base of the pole as centre, passing through this mark. In the afternoon the point where the shadow first touches this arc is also marked. Then a line drawn from the base of the pole to the mid-point of the line joining these two marks will run due north and south.

The line thus set out should be accurately prolonged, and its bearing read with the compass. This bearing will then give the *total* variation of the compass, including both the magnetic variation at that time and place and any inherent errors of the instrument itself.

Protractor. For plotting bearings the most convenient

instrument is a large circular protractor of transparent celluloid. For accuracy the instrument should be not less than 6 inches in diameter, and should be graduated in half-degrees. The instrument known as the 'Douglas Combined Protractor and Parallel Rule' is also very useful.

Ranging Poles (Fig. 59). These are straight poles of wood or light metal, 1 inch in diameter and 5½ feet long; the bottom 6 inches is pointed to enable the pole to be stuck into the ground. The ranging pole is painted in alternate bands of black and white, or black, white, and red, 1 foot wide, which enable it to be seen from a distance. The poles are used for marking stations and other points in a survey, and for the rough measurement of offsets.

Recording-frame. This instrument can easily be made at home. It consists of a frame of wood enclosing a square or rectangular aperture; round the inner edge of the frame small nails are driven in at intervals of three inches, so that thin string can be stretched between opposite nails across the aperture in both directions to form a grid. In use the frame is laid over a grave or other feature which it is required to plan in detail, the grid enabling the position of objects to be readily transferred to squared paper.

The dimensions of the aperture are a matter of choice; one side at least should not be longer than 4 ft., so that the frame can be used in a trench of that width. Alternatively, the frame can be made of short sections, about 18 inches in length, which can be bolted together to provide an aperture whose size can be varied to suit individual cases.

Ruler. For plotting in the field the surveyor should use a 12-inch wooden rule, preferably one fitted with a brass straight-edge. The ruler should be graduated in inches and tenths and sixteenths of an inch. All-metal rules are more accurate than

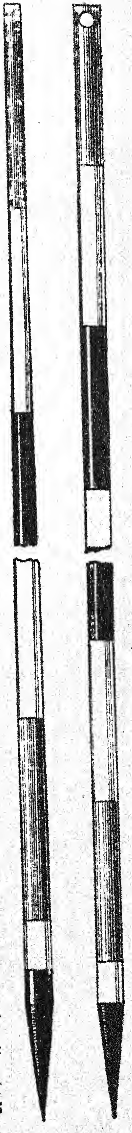


Fig. 59

the wooden article, but are very unpleasant to handle in cold weather out-of-doors.

Squared Paper. Squared paper is essential for plotting sections, profiles, and many types of survey, especially those in which the compass is employed. It is usually sold in single sheets measuring 17 by 22 inches, and in rolls 12 yards long and 30 or 40 inches wide; it is marked in squares of 1 inch, each of which is further divided into eighths, tenths, or twelfths of an inch. The first should be used for scales based on a power of 2

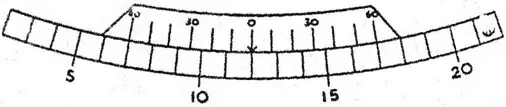


Fig. 60

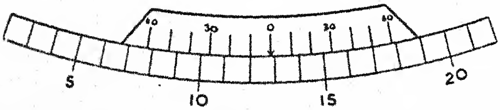


Fig. 61

(1 inch to 4 feet, 8 feet, etc.), the second for those based on a multiple of 10 (1 inch to 5 feet, 20 feet, etc.); while the last is particularly for drawings made at a large scale, where measurements are taken to the nearest inch or half-inch.

Staff. See *Levelling Staff.*

Vernier. The vernier is a device, named after its inventor, by which parts of a division may be read on a graduated scale. The type described here is that fitted to the Abney clinometer.

The vernier consists of a short scale moving on the main scale. It is graduated on either side of a central index in six divisions, numbered 0 to 60, each division representing 10 minutes of arc, or $\frac{1}{6}°$.

Reference to Fig. 60 will show that six divisions on the vernier are equal to five divisions on the main scale; hence each vernier division is $\frac{5}{6}$ of a division on the main scale. It is therefore clear that if the vernier in Fig. 60 is moved 10′ to the right,

the line marked 10 on the vernier will coincide with 13° on the main scale; similarly, if the movement is 50′, 50 on the vernier will coincide with 17° on the main scale (Fig. 61).

Hence we can formulate the following rule for reading the vernier: *For the number of whole degrees, read on the main scale backwards from the index to the last division before the index; for the parts of a degree, read on the vernier forwards from the index to the next division coinciding exactly with a division on the main scale.* Thus in Fig. 60 the reading is 12° 0′, and in Fig. 61, 12° 50′.

Verniers similar in principle, but graduated to read to much smaller fractions of a degree, are fitted to many other types of surveying instrument.

IV. RECORDING

THE records which the field archaeologist makes deal with three kinds of discovery, namely, structures, stratification, and loose finds. The recording of the first two is carried out by drawing measured plans and sections, and has been treated above under the heading of Surveying. The present chapter is concerned with the recording of loose finds.

The importance of loose finds in interpreting a site is discussed in detail later. It will be enough to point out here that they are the chief means of identifying a community both chronologically and culturally, and this identification can only be made if records exist not only of the finds themselves but of their positions relative to one another. Successful recording depends upon a proper appreciation of the meaning of stratigraphy, and a sound grasp of the methods whereby the stratigraphic context of each find is determined.

As in excavation, so in recording there is no ideal method which can be followed in all cases; each site must be treated according to its individual needs and circumstances. But whatever method of recording is adopted, it must fulfil two conditions to be effective: it should be possible, at least in theory, to

reconstruct the site with every find in its original position; and it should be possible to compare finds from one part of the site with those from other parts or from other sites, without fear of confusion, and at all times to ascertain quickly the exact position on the site from which any particular find originally came.

The degree of accuracy with which the position of finds must be recorded varies in inverse proportion to their frequency on the site. It will be obvious that on industrial sites, such as Romano-British potteries or prehistoric flint-mines, the number of finds may well run into thousands, even from a small excavation; it would be impracticable to measure and record the exact position of every one of these. The procedure for recording must therefore be somewhat simplified for finds which occur in large numbers.

In most cases pottery is the most common find, though on certain prehistoric sites it may be surpassed in numbers by, for instance, flint implements; these *common finds* cannot be recorded with the same degree of accuracy as rarer objects, which may be classed under the general name of *small finds*. Small finds include all objects of bone, metal, wood, jet, and shale; coins; and pottery or stone tools of especial interest.

The methods of recording outlined below may be applied equally well to industrial or occupation sites, where finds are numerous, and to sepulchral or ritual sites where they are scanty. It should, however, again be emphasized that these methods are by no means the only possible ones; they are given here because they have stood the test of experience on a number of different types of site.

In order to fix the position of any find, the site must be divided up both vertically and horizontally. The most convenient divisions in the horizontal plane are the existing trenches and cuttings, and in the vertical plane the stratified layers of the site. These natural divisions may be subdivided arbitrarily without limit, and the *exact* position of any find can be determined by horizontal measurements from a given set of reference points, and by vertical measurements above or below an arbitrary datum plane. Thus, on any site three things are

necessary for recording: a system of reference points; a system of numbering trenches; and a system of numbering layers. These three systems will be considered in detail later.

PROCEDURE

The procedures for recording pottery[1] and for recording small finds are slightly different, for reasons which have already been explained. In general, pottery is recorded by trench and layer numbers only, and small finds by their exact position determined by measurements from reference points. The recording of pottery is considered first.

RECORDING POTTERY

1. In each trench or cutting *one layer only* must be removed at a time. It may sometimes be necessary to start the excavation of a lower layer before an upper one has been completed, but in no case should two layers ever be removed together.

2. Each worker should have by him a wooden tray or large confectionery tin, in which the sherds from the excavated layer are placed. It is essential that *all* the sherds should be thus collected, however worthless or chronologically out-of-place they may seem. If any are thrown away before the whole contents of the layer have been examined together at leisure, the evidence is falsified and the whole system of recording becomes valueless.

3. Each tray or tin should have firmly attached to it a label written in indian ink, stating the name of the site, the numbers of the trench and layer being excavated, a description of the layer, the date, and the name of the excavator responsible (Fig. 62).

4. When the excavation of a layer is completed, all the sherds from that layer should be emptied from the tray into a stout glazed brown-paper bag, together with the label. The details on the label should be copied in indian ink directly on to the outside of the bag. If the sherds fill more than one bag, duplicate

[1] In the great majority of cases pottery is the most common find. The procedure outlined will, of course, apply equally well to any other kind of common find.

labels must be written. It is most important that the labelling should be done *immediately* the sherds are transferred from the tray, before any further excavation takes place. It should be made a strict rule *never* to pile finds loose on the edge of a trench, and never to use a tray or tin without a properly written label attached to it.

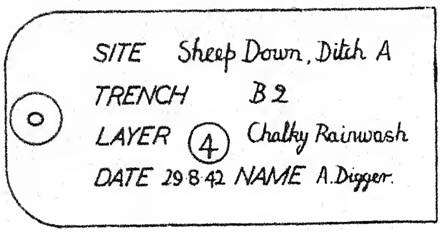


Fig. 62

5. At the end of the day's work all the bags should be collected and their contents examined, one bag at a time, for the purpose of writing up the record-books (p. 147). Each bag should be further marked on the outside with a serial number, and the same number should be added to the loose label inside it. These serial numbers are then copied into the bag list (p. 147).

6. At a later stage it will be necessary to wash the sherds free from adhering dirt. *This must not be done, however, until each sherd has been examined individually for traces of food-remains or other organic or mineral matter, which on analysis may yield valuable 'environmental' evidence.* Sherds bearing such remains should be marked (*v. infra*), but on no account washed, and should be preserved carefully for expert examination. Only *one* bagful should be washed at a time, and after washing the sherds should be spread out on *separate* trays to dry, with the loose label belonging to them. When dry they should be returned to their bag with the label, and the letter W (washed) added to both labels.

7. Finally, the washed sherds should be spread out on a table, one bag at a time, and examined individually. All parts of

rims and bases, decorated sherds, and pieces apparently belonging to the same pot, which it may be possible to stick together, should be put on one side for marking. Marking should be done with a mapping-pen and indian or white ink, according to the colour of the sherd; no marks should be made on broken edges, which may later be joined; the right place for them is the inside of the sherd. The mark consists of three parts, separated by dots. First, a capital letter or letters to indicate the site; next, the serial number of the bag to which the sherd belongs; and last, a serial number for the sherd itself, starting from 1 for each bag. Thus the mark X.43.8 on a sherd indicates that it is the eighth numbered sherd from the forty-third bag from site X. A reference to the bag list for that site (p. 147) will immediately give the trench and layer from which that sherd came.

8. Lastly, all the sherds, marked and unmarked, are returned to their bag with the loose label, and the letter M (marked) is added to both the labels. The top of the bag is folded over and secured with a pin, and it can now be stored with the other bags, arranged in order of their serial numbers, to await a detailed examination of their contents. When this examination takes place, it should be possible readily to find any marked sherd, and to compare it with any other, without fear of confusing them or returning them to the wrong bag.

SMALL FINDS

The term 'small find' covers any object other than pottery. Because of their comparative rarity and the importance of many of them for dating purposes (e.g. coins and fibulae), they should be recorded with greater care than is necessary or possible in the case of pottery. Accordingly, each small find is recorded separately as soon as it is found. The following procedure should be used:

1. The position of the find is measured from the appropriate reference points in the vertical and horizontal planes.

2. The find is placed in a bag, envelope, box, or tin, the outside of which is labelled. This label should give the name of the site, the trench and layer number, a description of the layer, the co-ordinates of the find-spot (i.e. two horizontal

measurements and one vertical one), a description of the layer, the date, and the name of the worker responsible.

3. To this label should be added a small finds serial number. All small finds are numbered serially in the order of their discovery, and a list of the numbers kept in a special book (p. 147).

4. In addition to the label on the outside of the container, a small price tag should be firmly tied to the object itself. This tag should be marked in Indian ink with the capital letters denoting the site and the serial number of the find. The object itself should not be marked in ink at this stage, as it may have to be sent to a museum or laboratory for cleaning or restoration.

To avoid confusion in numbering, all layer numbers should be written in a circle, thus 3, all small find serial numbers in a triangle, 36, and all serial numbers of bags in a square, $\boxed{43}$.

It should be clearly understood that the above division of finds, for recording purposes, into 'pottery' and 'small finds' is entirely arbitrary, and is useful only upon industrial and domestic sites, where the common finds are too numerous to be recorded individually. *On other sites where finds are fewer, and consequently of greater relative importance, every find, including pottery, should be regarded as a small find and recorded by the small-find procedure outlined above.*

THE SYSTEM OF REFERENCE POINTS

Every site requires a system of reference points for the purposes of recording and surveying. These points should be marked with wooden pegs driven firmly into the ground; one side of the peg should have a smooth surface planed at the top, on which identification marks can be written in red or blue pencil. Key pegs should have a small hook screwed into the top, to which the zero end of a measuring tape can be attached.

The system of reference points will naturally vary with the trench system employed. Where an area is to be examined by

trial trenches on the grid system (p. 50) a network of pegs will already have been laid out. This can be expanded by placing extra pegs along the lines of the main grid, which are parallel to the trenches. The pegs on two adjacent outer sides of this grid should be marked, one side in letters and the other in figures; the remainder of the pegs are then marked with reference to these (Fig. 33). Each trench will now have along one side a line of numbered reference pegs. The position of finds in the trench can now be recorded by one measurement *along* this line of pegs, by another *at right angles* to it, and by a third, in the *vertical* plane, made with the staff and level (p. 112) with reference either to an arbitrary datum plane, or to the nearest peg, if the heights of the pegs are known.

The same system can be adopted where trenches are dug individually and not on the grid system. Pegs are driven in at equal *horizontal* distances along both sides of the trench, about 1 foot outside the edge; they should be placed cornerwise, as shown in Fig. 64 and Plate VIII, the measurements between them being made from the centres of the tops of the pegs. The horizontal interval between the pegs should not be greater than 5 feet. The height of each peg should then be found with a staff and level, relative to an arbitrary datum, and each peg should be marked with this height and its horizontal distance from the end peg in the line.

The position of finds in the trench may now be quickly found by means of a simple instrument known as a *measuring-triangle*, which is illustrated in Fig. 63. The triangle *ABC* is made from light wood. The angle at *B* is a right angle, and the sides *AB* and *BC* should be 3 feet and 4 feet long respectively. In each of the arms *AB*, *BC*, a spirit-level is fixed so as to be visible from both sides, and the outer edge of both arms is marked off in inches from *B* on both sides.

To measure the position of a find in the trench the triangle is held level, with the side *AB* resting on the nearest of the line of pegs and in line with them, and the side *BC* vertically above the find. A measuring tape with a plumb-bob at the zero end is then held against the side *BC* at *X* and lowered on to the find. The co-ordinates of the find with reference to the nearest

peg are then given by the distance P (peg)—B, B—X, and X—F (find) (Fig. 64). Suppose that these distances are respectively 2 feet 6 inches, 3 feet 8 inches, and 4 feet 7 inches, and that the peg P is 35 feet from the end of the line and 6 feet 10 inches above the datum. Then the co-ordinates of the

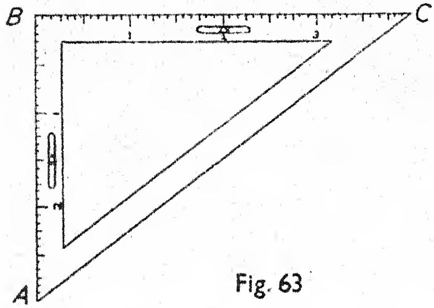


Fig. 63

find to be recorded will be: 37 feet 6 inches; 3 feet 8 inches; 2 feet 3 inches.

When an area is being cleared by the 'box' system the pegs should be placed at the junction of the baulks (Fig. 9), with intermediate ones between them where necessary. The hori-

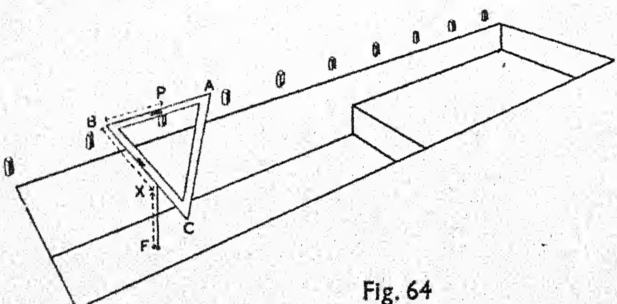


Fig. 64

zontal position of any find can then be found by measurement from any pair of pegs, and the vertical position by staff and level as before. Strictly speaking, measurements from *three* pegs are necessary to fix the position without doubt, since with two only there are two possible positions for the find, one on either

of the line joining the two pegs. If, however, the number of the cutting forms part of the record, as has already been explained, this difficulty will not arise, and only two measurements will be necessary.

THE SYSTEM OF TRENCH NUMBERS

The system of numbering employed for distinguishing trenches and cuttings will naturally vary with the pattern upon which they have been laid out. When using a grid of trial trenches the most convenient practice is to number in series, in Roman figures, each square of the grid contained between four reference points. The trenches which follow the sides of these squares are then designated by the square-number and a point of the compass, e.g. *III, W., XVI. N.*; or, if the grid does not run north and south, *XII. NE., XX. SW.*

Cuttings of a box system should be numbered in Roman figures in the same fashion. Each box can be further subdivided into parts numbered *a*, *b*, *c*, *d*, etc., running in the same sense as the numbers of the boxes themselves.

Where interrupted trenches are used it is convenient to give a subsidiary number to each small section of trench and to each separating baulk. Thus, in an interrupted trench *A* the excavated parts will be numbered *A*1, *A*3, *A*5, etc., and the baulks between them *A*2, *A*4.

THE SYSTEM OF LAYER NUMBERS

In every trench or cutting the layers should be numbered from 1 downwards, layer 1 being usually the turf and the humus immediately underlying it. *All* layers must be given a number, however tenuous or insignificant they may seem.

So far as possible corresponding layers in different trenches should be given the same numbers. For instance, excavation may reveal a layer of sterile sand covering the early part of a site, representing a period of abandonment. This layer should be given the same number in every cutting in which it appears, and extra layers above or below it subsidiary numbers (2*a*, 4*b*, etc.), in order to preserve as far as possible consistency of numbering throughout the site.

To assist in writing record labels during the excavation of a cutting, each layer should be marked in the section at the side of the trench by means of a label, giving the trench and layer number, held in place by a long nail.

RECORD BOOKS

Four record books should be kept on every excavation, besides the photographic book; they must be kept up to date as the excavation proceeds.

In the *trench book* is kept a list of all the trenches and cuttings excavated, with a record of the structures, stratification, and finds revealed in each one. The record is best kept in a loose-leaf note-book, one page being reserved for each cutting. The name of the site and the reference number of the trench should be written at the top; below, each layer is numbered and described in its proper order, together with a short list of the main classes of finds from it. To this should be added a list of the bag and small find numbers under which the finds have been recorded.

The *bag list* gives the numbers of the bags in their serial order; against each number is the number of the trench and layer from which the finds in that bag were excavated.

The *small finds list* gives the details of the small finds in the order of their discovery. The page is divided into columns, in which is recorded the information which has already been written on the bag or box containing the find. It is most important that this list should be filled up as soon as possible after a small find is excavated.

The *day book* is one of the most important records to be made on any excavation. It is a diary of the work, written up every day, giving details not only of the work done, but also of all the ideas and suggestions about the site and its interpretation which may occur or be made to the excavator. The day book is, in fact, the excavator's memory. The value of this kind of record is enormous both during the excavation and afterwards, when the material is being prepared for publication. For the excavator who makes no written records other than mere lists of finds, and trusts to his memory for the rest, will have at the end but the bare bones of his site; it is the small observations,

the hypotheses, the casual ideas which when later sorted and studied will most often clothe those bare bones in flesh and blood.

To summarize, the purpose of any system of recording is to make possible a theoretical reconstruction of the site. To do this the site must be divided up horizontally and vertically by means of three systems, that is, reference points, trench numbers, and layer numbers. Common finds (usually pottery) are recorded by their trench and layer numbers only, small finds by their exact position. Collective labels and individual marks on finds, together with cross-referenced index lists, enable the find-spot of any object, or the nature and present whereabouts of the finds from any layer, to be quickly and easily found. Finally, apart from the records of the actual finds, very full records are kept of the progress of the excavation and of the excavator's ideas about his work.

V. PHOTOGRAPHY

THE camera is an indispensable item of the archaeologist's equipment. With it he has the means of making quick, accurate, and objective records of his discoveries and observations; without it he must rely upon his memory and the unsatisfactory alternative of sketching.

To-day a camera is almost as common a possession as a fountain-pen; it is therefore assumed in what follows that the reader is familiar with the elementary principles of photography, and with the meaning of such terms as exposure, depth of focus, film-speed, and the like.

THE CAMERA

Success or failure in photography depends far more upon the photographer than upon his instrument or materials; to take good photographs of archaeological subjects requires, first and foremost, a sound practical knowledge of the basic principles of photography, and of the scope and limitations of the camera

and materials used; the actual type of camera and equipment is of secondary importance.

It is obvious, however, that among the many varieties of camera in use to-day there are some which are more useful for archaeological purposes than others. The merits and disadvantages of the main types are discussed below.

Stand cameras. 'Old fashioned', solidly-built cameras of this type are rarely used by the majority of amateur photographers, but are the stand-by of serious amateur workers and professionals. There is no doubt that, other considerations apart, they cannot be bettered for quality of results. Most cameras of this type are fitted with detachable lens-panels and double-extension movements, which make possible the use of long-focus and wide-angle lenses and the close-up photography of finds and museum specimens, as well as the copying of drawings and book illustrations. The usual negative sizes are $3\frac{1}{4}\times4\frac{1}{4}$ in. ($\frac{1}{4}$-plate), 9×12 cm., 5×4 in., $4\frac{3}{4}\times6\frac{1}{2}$ in. ($\frac{1}{2}$-plate), and $6\frac{1}{2}\times8\frac{1}{2}$ in. (whole plate); of these the last three, though suitable for studio use, are somewhat large and heavy for field-work. A $\frac{1}{4}$-plate camera, such as the *Sanderson*, *Thornton-Pickard*, *Una*, or *Sybil*, is probably the best all-round camera for archaeological work. It requires, however, more than an elementary knowledge of photography to get the best from it; with its necessary accessories it is heavier and more bulky than other types; and the cost of the negative material is high (about 7*d*. per exposure for plates, excluding processing).

Folding cameras. Folding cameras fitted with bellows and using roll-film are very popular among amateur photographers; the commonest negative sizes are $2\frac{1}{4}\times3\frac{1}{4}$ in. and $2\frac{1}{4}$ in. square. In the more expensive types focusing is by coupled rangefinder; in those of medium price by scale; the cheaper models have fixed focus lenses of small aperture. Cameras of this type are suitable for the photography of sites and excavations, their suitability increasing roughly with their price. They do not, naturally, possess the flexibility of the plate camera, and are not generally fitted for close-up work or for copying.

Miniature cameras. Under this heading may be placed a great variety of cameras using 35 mm. film. Their chief advantages

be processed, if desired, immediately after exposure; this is an advantage where the excavator is unwilling to demolish an important structure or section before he is certain of having an adequate photographic record of it.

Plates, cut film, and film-packs also have the advantage for the photographer who does his own processing that each exposure can be given individual treatment in developing, which is not practicable with roll-film. The chief disadvantage of plates is their relatively high cost, their fragility and their bulk; on the other hand they are generally available in a wider range of emulsions than other materials.

The archaeological photographer is concerned with static subjects, often of low contrast; for his purpose, therefore, emulsions of relatively low speed, fine grain and moderate to high contrast will generally be most suitable. For many subjects among sites and finds panchromatic material is not essential, and orthochromatic plates and film may actually give a better rendering of texture. It should be remembered, however, that orthochromatic emulsions are not sensitive to red, so that red, orange and brown parts of a subject will photograph much darker than they appear to the eye; this fact may be used to give increased contrast of tones in certain cases, but when the subject is predominantly of these colours it is preferable to use panchromatic material, in order to reproduce the approximate scale of brightnesses seen by the eye.

Suggested materials in the Kodak range are: plates, *P.300* and *O.250*; cut film, *Commercial Ortho*, *Panatomic X*, *Antihalation Safety*; roll-film, *Verichrome*, *Panatomic X*; 35 mm. film, *Panatomic X*. Other manufacturers produce similar materials of approximately the same type.

For the photography of finds, particularly where white shadowless backgrounds are required (p. 159), *P.150* plates, *Panchromatic Process* cut film, and *Microfile Panchromatic* 35 mm. film, all manufactured by Kodak, are suitable.

Colour film, giving after processing transparencies approximating to natural colours, suitable for projection as lantern slides, is available in two types. The additive process, represented by *Dufaycolor* (available as cut, roll and 35 mm. film)

gives a somewhat dense transparency, often too dense for satisfactory projection, in which the colour-forming *reseau* is noticeable. The subtractive process, represented by *Kodachrome* and *Ilford Colour* (the former available as cut and 35 mm. film, the latter as 35 mm. film only) gives images formed by dyes which are virtually grainless and project very well. The rendering of colours is fairly accurate, but tends towards over-brilliance or harshness, especially in the more delicate tones of the original.

Successful colour photography with any of these materials requires adequate lighting and great accuracy of exposure. Owing to the prohibitive cost of colour-printing, it is not likely that colour-photographs will play any great part in the illustration of archaeological reports for some time to come; their main value to the excavator and field archaeologist is as a means of recording details that are imperfectly shown in monochrome, and as an aid in teaching and lecturing.

PHOTOGRAPHIC RECORDS

Records should be kept of all photographs taken on an excavation, to assist in identifying the negatives after processing and in tracing errors in the apparatus or the photographer's judgment. For this purpose the following data should be noted in columns in a special book:

1. The serial number of the negative. (The numbers should run from 1 upwards; if more than one camera is used those taken with the second instrument should start, say, from 1001.)
2. The date and the time of day.
3. Full details of the subject.
4. The lighting.
5. The stop and exposure given.
6. The make of film used.
7. Accessories used (filter, lens-hood, supplementary lens, etc.).
8. Any further history of the photograph (published, destroyed, filed for reference).

PROCESSING

The archaeologist should not attempt to process his negatives unless he is a skilled and experienced photographer; it is far safer to entrust them to a firm of repute which is prepared to give them individual attention. The firm should be asked always to use a fine-grain developer, and the formula employed should be ascertained, as certain types of fine-grain developer require an increased exposure to be given. When negatives are sent for processing the serial numbers should be stated, and an arrangement made with the firm that each one shall be marked in one corner with its number, preferably by scratching the emulsion with a fine point. It is easier and safer for the firm to do this while the negatives are still in one strip, than for the owner to attempt to identify each one separately from his records after they have been returned to him cut into separate frames.

In the first place, one print should be made from each negative, including faulty ones. For negatives 6 by 6 cm. and larger a contact print will be sufficient, but miniature negatives should be enlarged to about 6 by 9 cm. These prints will enable a choice to be made of negatives suitable for further enlargement.

FILING PHOTOGRAPHS

The contact prints should be filed as in a card index. On the back of each print should be written in indian ink the serial number of its negative and details of the subject. If these prints are kept in a small portable file on the site, it will be a matter of moments to find out whether any particular subject has been adequately recorded by the camera.

Negatives are best filed in the special books of transparent envelopes made for the purpose. Those 6 by 6 cm. and larger should be filed separately; miniature negatives are most conveniently handled in strips of four or six, and can be stored in Celophane envelopes. Glass negatives should be kept like a card index, each plate being enclosed in an envelope cut to the right size.

It is hardly necessary to add that negatives should always be handled *by the edges* and never by touching the surfaces.

LIGHTING

It is a golden rule never to take photographs of excavations in full sunlight. For unless great care is exercised the hard, harsh shadows cast by the sun will print out too dark and will obscure the detail beneath them. The photographer should therefore wait, whenever possible, for a cloud to obscure the sun, or, failing this, should try to screen his subject from the direct rays.

For general views of a site, designed to show up the relief, the sun should be in front of the camera and preferably a little to one side; with the light coming from behind the camera, as is often advocated in manuals on photography, much of the relief will hide its own shadows, and the photograph will appear dull and flat.

A great deal can be done to improve the normal lighting of a subject in the open air by the judicious use of white reflectors. These are particularly useful in dealing with dark subjects such as the sides and bottoms of pits, ditches, and deep post-holes.

For photographing inscribed slabs and other objects with detail in slight relief the light should shine almost in the same plane as the face of the slab, in order to cast shadows in the lettering. Where the face of the slab is much weathered, however, the light must not strike at too small an angle, or the irregularities of the surface will be thrown too much into prominence.

The use of artificial light for archaeological photography appears to have been tried hitherto only in cases where daylight was totally lacking (e.g. flint-mines and hypocaust-flues). The application of flash-light technique to the photography of ordinary excavations appears, however, to be quite practicable, and would much improve the standard of photographs of pits, ditch-sections, deep cuttings, and other subjects normally only obscurely lit by daylight.

The source of light most readily available is the flash-bulb, which has superseded the older and somewhat dangerous flash-

powder. The bulb is filled with metal wire or foil, and has a screw-cap which fits the bulb-socket of a pocket-torch; it is fired electrically by an ordinary torch battery, and gives an extremely intense flash of approximately 1/40th second duration. Bulbs should always be used in suitable reflectors, both for efficient lighting and for safety, as they are very occasionally known to burst on ignition.

If two or more bulbs are used simultaneously, they should be wired in parallel; if wired in series, one bulb may fire a little early, thus breaking the circuit and preventing the ignition of the remaining bulbs. Where wire connexions are used, so that the bulbs can be fired at a distance from the operator, a battery of higher voltage should be employed to compensate for the voltage drop along the wires.

The use of flash-bulbs requires experience, as preliminary arrangement of the lighting is not possible. Synchronizers, which automatically fire the bulb when the shutter of the camera opens, are available for, or built in to, some cameras (e.g. Leica, Contax, Kine-Exakta). In other cases the shutter should be set for a brief time-exposure (usually marked B); the bulb is fired as soon as the shutter is opened, and the shutter is immediately closed. To compensate for the extra exposure involved in this procedure the iris-diaphragm should be closed to a small aperture, which can only be determined by experiment.

The best arrangement of artificial lights will depend upon circumstances; they may be used either to increase the general illumination, or to lighten particularly dark areas and shadows cast by daylight. Great care should be taken that the artificial illumination does not itself cast sharp shadows.

THE VIEW-POINT

Putting aside questions of exposure and processing, a photograph may be said to be made or marred by two things—the lighting and the view-point. That these two are to some extent interdependent will be obvious; it will also be clear that in many cases the view-point, and therefore the direction of the light, will be determined by the nature of the subject. A ditch section, for instance, can only be photographed properly from

a direction at right angles to its face, and the photographer must make what he can of the lighting he gets from that position.

Where a choice is possible, however, the view-point is often of great importance. Plate XI shows three photographs of the same excavated site from three different view-points vertically above one another. The upper photograph was taken with the camera at eye level, about 5 ft. above the ground; the middle one from the top of a large plasterer's trestle 10 ft. above the ground; and the lower one, which alone gives an adequate idea of the excavated structure, from the top of a large tripod 22 ft. above the same point.

The importance of a high view-point for this type of photograph is obvious. Occasionally there may be close to the site a tree, telegraph-pole or building which can be climbed, but generally the highest point immediately available will be the top of a dump. Thus where there is no ready-made high view-point an artificial one must be constructed.

The ideal arrangement is a folding tetrapod of the type figured by Dr. J. G. D. Clark in his book *Archaeology and Society* (Fig. 9), which has a small platform at the top, some 20 feet above the ground; the whole device can be moved to any part of the site, and the height of the platform adjusted at will.

A cruder version of the same arrangement can be made with a long ladder and two scaffolding-poles, securely lashed together at their upper ends. A lower platform can be very simply constructed from two plasterers' trestles and a couple of planks.

Movable platforms of this kind are particularly useful for recording photographically the excavation of pits and graves. The platform is set up immediately over the spot and the camera fixed in position, preferably by a universal-joint tripod head firmly attached to the woodwork, so that it points vertically downwards. Photographs are then taken at intervals to record the progress of the excavation.

Mr. P. L. O. Guy has described the use of a balloon for taking vertical photographs of excavated sites (*Antiquity*, VI (1932), 148), but, apart from the high cost of the equipment, it is doubtful whether this method would be practicable in Great

Britain, where the necessary condition of still air is rarely obtained.

In the same article is illustrated an extending, self-supporting, portable ladder giving a view-point for photography up to 30 ft. from the ground. The writer has had constructed a ladder of similar type made from aluminium alloy, mounted on a wheeled chassis, which can be moved about and erected by one person, will fold flat for transport on a lorry, and is light enough to man-handle on to the top of a dump, where the maximum height is required (Plate XII).

THE PREPARATION OF SUBJECTS FOR PHOTOGRAPHY

Needless to say, any part of a site which is to be photographed must first be thoroughly cleaned. A photograph of an uncleaned subject is a photograph wasted, for it is impossible to tell what is part of the structure and what is merely loose earth and dust. All loose earth must be brushed away with quick sharp strokes of a stiff brush. The photograph should be taken as soon as possible after brushing, as otherwise the traces of soil and dust which remain will dry out and give a flat dull appearance to the print.

Certain subjects are improved for photography by lightly wetting with a fine spray of water. Sections which have dried and lost their contrasts after several days' exposure are much improved by this treatment, and it is essential for bringing out the colours of tessellated or encaustic tile pavements. Here again the photograph should be taken as soon as possible.

Special features to be emphasized in the photograph should be marked with arrows or circles cut out of white card. Layer-junctions in sections may be outlined with narrow white tape fixed to the side of the cutting with pins at short intervals.

The photography of small finds, especially for half-tone reproduction, is a skilled business, and will normally be carried out by a professional photographer in a museum or elsewhere. Since, however, there is always some risk of damage to such objects in transit from the site, it is advisable for the excavator to photograph at least the more important of them, for record purposes only, as soon as possible after their discovery.

For this purpose a simple apparatus should be constructed, consisting of a sheet of plate glass or transparent perspex, about 18 in. square, raised on two opposite sides or at the corners on supports not less than 18 in. high. Beneath the transparent sheet, sloping downwards and forwards from its rear edge, should be fixed a sheet of plywood or thick card covered with white paper or paint, with a matt surface, to act as a background. The objects are laid on the glass with a scale of inches or centimetres beside them, and the camera is mounted directly over them to obtain a vertical view; the whole apparatus should be screened from direct sunlight when the exposure is made.

The object of this arrangement is to provide a white background against which the objects will stand out without casting shadows. When estimating the exposure with an optical or photo-electric meter the white background should be temporarily obscured with a piece of dark card held beneath the glass; if the reading includes the light reflected from the background the objects themselves will be under-exposed.

II THE INTERPRETATION OF THE EVIDENCE

VI. INTERPRETATION

ıry duty of the excavator is to record *facts*. If he ɔublish the measurements of the structures he has nature of the strata covering and filling them, and ıs of the finds which they contain, he fails in the ity which is implicit in the act of excavating. Such no right to excavate, still less to foist upon the public tions unsupported by evidence and incapable of being ıdependently.

blication of *facts* is of the first importance; for in ʒy, apart from what is embodied in measured plans graphical sections, in photographs and in drawings ects found, there are no facts; all the rest is hypothesis. way detracts from the scientific value of archaeology; ntrary, it is true not only of archaeology, but of all nces, and is the only justification for calling archaecience at all. For the scientific method consists in and arranging particular facts, and forming general es from them, and checking those hypotheses by xperiment; and the hypotheses are held to be true only as and so long as they explain the observed facts.

excavator, therefore, in interpreting the evidence of n, should be guided by two principles: first, that the must be interpreted as a whole and presented as a ıd, second, that no evidence can be interpreted otherı by working hypotheses.

terpretation of excavation results may be divided into es. In the first the archaeologist endeavours to assign o each event or period represented on his site, and a to each structure and object found; in the second stage this primary information to define the cultural, social,

and economic background of the community with which he is concerned.

The importance of thinking in terms of communities cannot be too strongly emphasized. Archaeology is concerned, it is true, with inanimate objects, and it is easy in studying them to forget that they are but the expression of human purposes and the fulfilment of human needs. But it should always be remembered that it is just these human purposes and needs, and not the objects by which we know and recognize them, that are the real subject of archaeological studies.

CHRONOLOGICAL INTERPRETATION

It is in matters of chronology that one of the differences between archaeology and the study of written history becomes most apparent. Written history is concerned largely with named individuals and with absolute dates: in archaeology, at least in these islands, there are very few names and, until the expeditions of Julius Caesar, no absolute dates at all. For the most part, therefore, the archaeologist is compelled to 'date' the building of a structure, the deposition of a layer, or the making of an artefact by means of cultural labels such as 'Neolithic B', 'Deverel-Rimbury', or 'Iron Age A2', the culture periods themselves being only vaguely defined in terms of years.

The dating of layers and of artefacts is interdependent. That is to say, a *terminus post quem* can be assigned to a layer in which an artefact of known date is found; while a *terminus ante quem* is given for the making of an artefact which is found in a layer of known date. It must be clearly understood that these *termini post* and *ante quem* are the closest that the archaeologist can get (at least with present methods of research) to an absolute date.

The first step in dating the various phases on a site is to determine the order in which the stratified layers were laid down, the guiding principle being, of course, that any layer must have been deposited earlier than the one above it and later than the one beneath it.

The interpretation of stratification is by no means easy, and can only be learnt by prolonged study of exposed sections and

published drawings. One fatal danger, that of studying stratification in one plane only, is illustrated in Fig. 65. To the left of the mound is shown a layer of gravel thrown up from the ditch outside, directly beneath which was found a complete pot. From the stratification it appears that the pot ante-dates the gravel layer, which on other evidence was dated to the Middle Bronze Age; the pot, on the other hand, was obviously of the Iron Age, some ten centuries later. The conflict of evidence was resolved by cutting another section at right angles to the first, which showed that the pot had actually been inserted beneath the gravel layer, by means of an oblique pit lying behind the line of the main section.

The dating of layers by the artefacts found in them is based upon one cardinal principle, namely, that the time at which the layer was deposited must be later than the date of the *latest* object found in it, always providing, of course, that the possibility of material having been intruded by rabbits, etc., is ruled out. Thus a ditch surrounding a Bronze Age barrow, which contains right at the bottom both Bronze Age and Romano-British pottery, must have been cut, or re-cut, in Romano-British times or later, for however early any of the other pottery may be the Romano-British sherds could not have found their way there unless the ditch was open at that period: The principle involved is so simple as hardly to require statement. It is, however, one of the greatest importance, and should never be ignored for the sake of supporting a preconceived theory, however attractive.

When one layer is completely covered over by another so that no later intrusions are possible it is said to be 'sealed'. If the layer sealing it above is itself securely dated, it must follow that every object in the sealed layer is of earlier date. This is often the only way of dating artefacts which have too few distinguishing features to assign them to this or that cultural period on their own merits.

Fig. 65 is given as an example of how the chronology of a site is interpreted; the section chosen is that of a round barrow. *A*, *B*, *C*, *D*, and *E* represent potsherds of five different periods; for the sake of archaeological verisimilitude they may be

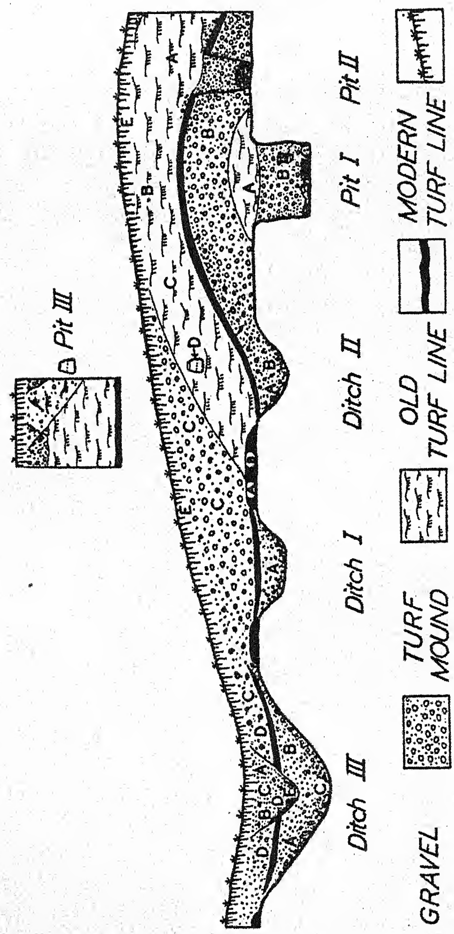


Fig. 65

equated respectively with the Neolithic, Early Bronze, Middle Bronze, Iron, and Romano-British periods. Study of the section reveals the following series of events:

1. Ditch I is dug by Neolithic people, who drop *A* sherds in it and on the surrounding turf.

2. Ditch I is abandoned and the site remains unoccupied. Turf grows over the ditch.

3. Pit I is dug by a family of Beaker folk, who deposit in it the body of one of their number, together with a Beaker. Some of the surrounding turf, which contains some *A* sherds, is piled up over the pit. Ditch II is dug, and the excavated gravel is piled up to form a small barrow. Some Beaker sherds are dropped in the mound and on the surrounding turf. (It should be noted that although the grave-pit is sealed by the pile, the Beaker in it is not interpreted as being earlier than the Neolithic period represented by the *A* sherds in the turf; these merely provide a *terminus post quem* for the building of the turf pile.)

4. Ditch II silts up, *B* sherds falling in from the mound, *A* sherds from the surrounding turf.

5. The site is again abandoned. Turf forms over the mound and ditch.

6. A community of the Middle Bronze Age dig Pit II in the earlier barrow, and deposit in it a parcel of cremated bones. Turf is scraped up over a wide area and piled up in a large mound which completely covers the earlier barrow and its ditch. This turf contains sherds of both *A* and *B* periods, and other sherds, *C*, are dropped by the present builders. Ditch III is dug and the excavated gravel is piled up round the turf mound; more *C* sherds are dropped.

7. The site is once more deserted. Ditch III silts up, sherds of periods *A*, *B*, and *C* all falling in. Finally silting ceases and a turf-line is formed.

8. An Iron Age community occupy the site. Pit III is dug obliquely into the mound right through the gravel layer, and a pot is placed at the bottom. Sherds of period *D* fall on the turf-line in ditch III, and the mound is somewhat disturbed, filling up the ditch with material which includes *A*, *B*, and *C* sherds.

9. Romano-British descendants of the Iron Age community partially re-cut ditch III, through the old turf-line. Some of their pottery, *E*, falls to the bottom of the re-cut ditch, and more is dropped on top of the mound.

10. The recent ditch silts up, and sherds of all periods fall in with the turf and material from the mound.

In fairness to the reader inexperienced in excavation it should be confessed that the example just quoted represents an archaeologist's nightmare. The section is stratigraphically possible, and is made up from various actual observations of the writer. It is most unlikely, however, that any barrow would ever present such a long sequence of cultural periods or such a profusion of pottery. This has been provided expressly to illustrate that however many periods may be represented in a single layer, it is the *latest* one only which dates the layer.

The example just given serves also to illustrate the critical positions for dating evidence in such structures as ditches, pits, and mounds; these may be further considered in detail here.

Ditches and pits. The silting of a ditch dug in chalk,[1] gravel, or other solid material takes place in three stages. At first silt collects rapidly at the bottom, derived from the sides under the influence of weathering, especially frost. This silt is usually coarse and contains little earth. The second stage of silting is reached when the weathering of the sides has proceeded far enough to undercut the turf and subsoil at the lip of the ditch. This falls in, bringing with it any artefacts which may previously have been deposited there. This secondary silting is usually fine and earthy. Silting continues slowly until the sides of the ditch are completely covered, so that no more weathering is possible.

These two stages of silting are complete a few years after the original digging of the ditch. Experiments made on chalk subsoil by General Pitt-Rivers[2] suggest a period of ten years or less; on less compact material such as gravel the period is probably very much shorter.

In the third stage silting continues much more slowly. Gradually, as the hollow of the ditch fills up and the lips are denuded, the slope of the silt becomes flatter, until finally it reaches the 'angle of rest', at which no more silt will fall of its own accord. At this point, if the conditions are suitable, grass and weeds will begin to grow on the silt, and will quickly

[1] *Antiquity*, IV (1930), 97. [2] *Excavations*, IV (1898), 24.

form turf which will bring the process of silting entirely to an end.

From this it will be clear that artefacts found in the primary (or rapid) silt are most likely to be contemporary, or nearly so, with the digging of the ditch. Those found in the secondary silt may also be contemporary, but may equally well be later additions, or earlier than the ditch, if they are derived from the adjacent turf and soil which fell in at this stage.

Mounds and banks. Artefacts found in or on the old turf-line beneath the centre of a mound or bank must ante-date its construction, though not, of course, by any great length of time. On the other hand, objects found at the same level beneath the *tail* of a mound may well have been dropped there *after* the building of the mound, from which material has later silted downwards and covered them up.

Artefacts found in the *body* of a mound may be earlier than or contemporary with its construction. Building material consisting of soil or turf may well contain objects dropped at an earlier period; but objects found in *clean* chalk rubble, gravel, and other material which has clearly been derived directly from a ditch, were probably dropped there by the builders themselves.

Post-holes. Objects found at or near the bottom of a post-hole are probable contemporary with its construction, and are almost certainly so if they are sealed beneath surviving traces of the wooden core of the post, or beneath packing-stones. Material found nearer the top of the filling, however, is less useful for dating purposes, since it may have fallen in at any time owing to the decay or removal of the post.

Walls. Critical artefacts for dating the construction of walls are those found beneath the foundations. Material in the rubble used for filling up the bedding-trench may be derived from an earlier period, and the same is true of datable objects such as tiles and inscribed stones which have been built into the wall itself.

Entrances. It is at the entrance of any enclosure, where all movements in and out are canalized and arrested, that the history of a site is best seen in epitome. This is particularly

true of fortified enclosures such as hill-forts, where the entrance, as the most vulnerable part of the defences, reflects most sensitively in changes of design the current of contemporary events. Indeed, so complex and difficult are the problems raised by this type of site that no one should think of examining the entrance of an enclosure, whether fortified or not, unless he is qualified to do so by long experience in excavation.

The value for dating purposes of the various objects found in an excavation is, of course, by no means uniform. Obviously inscriptions, and more especially coins, stand in a class by themselves, as bearing internal evidence of their date of manufacture in actual years. Yet the interpretation of coin evidence is by no means easy, and the presence of a single coin in a layer is more of a snare than a help in dating.

As far as Roman Britain is concerned (and it is in this period, of course, that coin problems are of most importance), there are two main complications. The first is that while the *average* lapse of time between the issue of a coin at a Continental mint and its arrival in this country is comparatively short, the *actual* lapse of time in the case of the individual coins with which the excavator is concerned may be very much longer, and is in any case indeterminate. The second complication is found in the withdrawal of coin from circulation by hoarding in times of economic instability, and its return to circulation at a later date. Finally, the persistence in circulation of old coinage must not be forgotten; it is even to-day a common occurrence to find in one's pocket copper coins minted nearly a century ago.

It should be understood, therefore, that the coins from an excavation are valuable as chronological evidence only if there are enough of them to be treated statistically; conclusions drawn from small numbers or from individual coins must be treated with the greatest scepticism.

Inscriptions and coins are the only objects which bear internal evidence of their date. Other objects can only be dated either from their stratigraphical position above or below dated finds, or from actual association in a closed deposit with dated finds, or, finally, upon typological grounds.

The comparative study of types is the basis of archaeological

chronology. If objects of one type are collected and arranged in a typological series, upon the assumption that the technically simple and the artistically unsophisticated represent original forms (an assumption, let it be said, which is by no means universally valid), then such a series will provide a relative time-scale which can be used to give a relative date to any object which can be fitted into it upon typological grounds. Moreover, if one or more stages in the sequence of types can be securely dated, the relative time-scale is converted into one which has, albeit with no claim to precision, an absolute value.

It will also be clear that the more rapidly changes take place in a type the greater will be the number of 'steps' in the series, and the greater the accuracy with which any new find can be placed in that series. The ease with which a typological series may be constructed varies according to the type concerned; it depends upon the rarity of the object, the plasticity and durability of its material, the simplicity of its form, and its intrinsic value.

'Common things,' as General Pitt-Rivers said, 'are of more importance than particular things (i.e. *rarities*), because they are more prevalent.' Rare types, precisely because they are rare, cannot easily be arranged in a comparative series.

It will be equally clear that a plastic material provides greater opportunities for changes in form and design to be made than one that is intractable. A bone weaving-comb, for instance, is limited to a certain size and shape by the form of the original bone from which it is made, no matter to what people or period it belongs. On the other hand, the variations of shape which can be produced in vessels of plastic clay are virtually unlimited.

Again, changes are more likely to be made in the design of fragile objects which are frequently replaced than in those to which a more durable material gives a longer life; and objects of intrinsic value or ceremonial importance will be longer preserved and less frequently replaced than those of merely everyday use and worth.

Simplicity of design, too, has an important effect in inhibiting change. Simple forms persist, complex forms change. A series

of motor-cars, for instance, of the last twenty years could probably, upon inspection, be arranged correctly in the order of their manufacture without difficulty; but an attempt to do the same with a series of axes or any other simple tool of the same period would meet with ill success.

From all these considerations it will be clear that the most useful dating material is *pottery*; next in order come objects of metal, and after them those of bone and stone. These last, with the exception of a few very distinctive types, cannot be said to be useful for dating except in terms of millennia; no site can be said to be closely dated upon the evidence of stone implements alone. Thus, so far as these islands are concerned, the dating evidence of *pottery* should be given preference, *ceteris paribus*, over other sources of evidence.

THE NUMERICAL VALUE OF DATING EVIDENCE

In using potsherds or other objects for dating purposes, it must be remembered that their value as evidence is dependent upon the numbers in which they are found associated.

It should never be taken for granted that any object discovered is necessarily in the same position as that which it occupied in antiquity; roots, rabbits, moles, and in particular earthworms[1] constantly disturb the soil, and in doing so may remove objects from one deposit to another without leaving much trace of their activity; small objects may also be displaced when the soil cracks in a prolonged dry summer.

It will thus be clear that single objects do not constitute good evidence of date, because the possibility of disturbance cannot be ruled out; *three* objects associated in a layer or structure should be the minimum number acceptable as valid evidence, and even then caution should be exercised in basing any conclusions of importance upon such evidence.

Therefore on a site where the finds are scarce and chronological problems have to be solved, it is essential that as much ground as possible should be excavated, in order that the finds

[1] The effect of the earthworm upon the formation and alteration of stratified sites is scarcely recognized among field archaeologists. Darwin's monograph *Vegetable Mould and Earthworms* deserves the closest attention of every excavator.

may be sufficiently numerous to constitute valid and incontrovertible evidence.

THE INTERPRETATION OF FUNCTION

Besides ascribing to his finds a date, the archaeologist must also attempt to ascertain their function. In this he has to depend less upon rules and principles and more upon experience; and for this reason, perhaps, the attempt to discover the real purpose of an object or structure is often too soon abandoned.

It is obvious, however, that if the archaeologist is to adhere to the principle of viewing his evidence as a whole, it is not enough to suggest *when* an object or structure was made and used; he must try also to decide *what* it was used for. To label a find in the style of older antiquaries as 'iron object', 'horse-trapping', 'part of a chariot', or 'cult-object', inspires neither interest nor confidence; and it may be remarked that the adjective 'ritual' has been so misused as almost to have become a signature of ignorance.

It will be clear that the chief requirement for what may be called the *functional* interpretation of finds is a thorough knowledge of the methods and tools employed in the more common crafts. The archaeologist should be familiar, therefore, with the equipment of the potter, the weaver, the carpenter, the husbandman, the miller, and the metal-worker, especially those of primitive and peasant communities; and of the making of pottery at least, as the most important type of artefact with which he deals, he should have, if possible, some practical first-hand experience.

Much of the work of interpretation involves the reconstruction, on paper at least, of objects and structures which have decayed or have been destroyed. This is particularly true of buildings, of which the most that the archaeologist can usually hope to recover, especially in this country, is the ground-plan of foundations or post-holes. It is therefore essential for him to be familiar with the architectural elevations corresponding to various ground-plans, in both wood and stone, which are to be found among primitive peoples to-day. Much light, too, may be thrown upon the lay-out of early settlements in this country

by consideration of the 'town-planning' of modern communities in other parts of the world having a similar primitive economy.

In interpreting the ground-plans of timber buildings size is an important factor. A circular hut, for instance, can be built without a central support for the roof, up to a certain size; above this size the roof-span will be too great, and a central support must be introduced. If, therefore, a large circle of post-holes is found, with no trace of a central post, it is unwise to interpret them as the remains of a *roofed* building, even though the ground-plan is identical with that of a smaller type of hut.

From what has been said above the value of some knowledge of cultural anthropology will be evident. Too much importance and weight should not, however, be attached to apparent parallels between our own prehistoric communities and primitive communities existing to-day. To suppose that modern 'savage' peoples are culturally static, and therefore preserve as it were *in vitro* the culture of prehistoric periods is a common but dangerous fallacy.

So far we have dealt merely with the immediate tasks of interpretation, in terms of chronology and function. We have the rough outlines of the picture, but the details and the frame are still to come. We have identified, let us say, a community which occupied a certain site, and we know the period at which it flourished and the kind of material equipment that it possessed; but there are still many questions to be answered before we can say that our task as archaeologists is done.

To what cultural group, for instance, does our community belong? Are they native people, or are they foreign immigrants, and if so, from where do they come? What was their food supply; did they practise agriculture, and, if so, what was the size and extent of their fields, and how were they tilled? What crafts did they practise? What evidence is there of trade with other communities, and by what routes? How large was the community; does it show any signs of growth or diminution, and from what causes? What were its religious practices and beliefs? What evidence is there for its social organization?

To these and many other questions there may be no answer in the evidence at hand; but all of them must at least be asked.

It is for answering such questions, questions not about stones or bones or sherds of pottery, but about *people*, that the science of archaeology exists. The archaeologist has no right to that name unless he can look beyond his potsherds and post-holes to the only proper subject of his study, the men who made and used them.

PART IV THE PUBLICATION OF THE EVIDENCE

VII. THE PUBLICATION OF ARCHAEOLOGICAL REPORTS

THE importance of publishing proper reports of archaeological research, and especially of excavations, cannot be too strongly emphasized. For, as has already been said, the excavation of a site involves its destruction; once excavated, the evidence cannot be reconstituted except from the records made by the excavator. Failure to publish these records, therefore, is as much a crime against science as the deliberate suppression of a newly discovered historical document.

Publication is thus an integral part of excavation, and arrangements should be made whenever possible *before* excavation starts, to ensure that the results are published fully and without delay.

It should be realized, however, that notwithstanding its great importance, publication is governed by certain practical limitations, the chief of which is expense. The media available to the excavator for the presentation of his report fall into three groups:

1. Journals of archaeological societies of national scope (e.g. *The Antiquaries Journal*, *The Archaeological Journal*, *The Proceedings of the Prehistoric Society*, *The Journal of Roman Studies*).
2. The journals of the numerous local archaeological societies.
3. *Ad hoc* publications produced and financed by a museum or by private individuals.

The circulation of all these is relatively small, and the cost of their publication proportionately high, nor are the available funds large. Moreover, space in the 'national' journals is

limited, and should be reserved if possible for material whose importance merits the widest publicity.

It will be clear, therefore, that the best place to publish the reports of small-scale operations, with which this book is concerned, is the journal of the local archaeological society. The prospective excavator should, therefore, if circumstances permit, approach the editor of this journal, *before* digging starts, in order to ensure that space will be available for the report at some future date.

THE TEXT OF THE REPORT

No hard and fast rules can be laid down for the arrangement of a report, which must obviously depend upon the nature of the subject-matter. The following scheme, however, is given as an outline of the essentials.

1. Introduction.
2. Short summary of the main results of the work.
3. Detailed description of the structural finds.
4. Discussion of the significance of the finds, both structures and objects.
5. Appendices describing the objects found.

1. *The introduction.* The introduction to the report should include the following information:

(*a*) The name and locality of the site, with map references.
(*b*) The circumstances leading to its discovery and examination, and brief indications of any previous research.
(*c*) The names of the persons and societies responsible for carrying out the work. (Preferably in a footnote.)
(*d*) Acknowledgments of help received, financial and otherwise. (Preferably in a footnote.)
(*e*) The condition of the site at the time of writing (i.e. 'destroyed', 'threatened with destruction', or 'restored and preserved').
(*f*) *The museum or private collection in which the finds have been deposited.* This important point is all too often omitted from reports.

2. *The summary*. The summary is given to enable the reader to discover at a glance what the report is about, without reading right through it. This provision is of great value to research workers, who may have to consult many hundreds of reports in search of some particular class of object or site. The summary should mention:

(*a*) The cultural sequence found on the site.
(*b*) The structural remains, if any, connected with each stage in the sequence.
(*c*) The purpose, known or conjectured, of these structures.
(*d*) The evidence (pottery, etc.) by which the site is dated.
(*e*) Any small finds of a particularly rare kind.

3. *Detailed description of the structural finds and stratification.* So far as possible this section should be confined strictly to the description of the finds, that is, to the presentation of the evidence; discussion of the *meaning* of the evidence should be reserved for the following section. For it should be borne in mind that the excavator's judgments upon his discoveries, while in the nature of things likely to be better informed than those of others, are yet not final or infallible. It is only right, therefore, that the *facts* should be kept separate from the excavator's personal interpretation of them.

This section should be prefaced with a description of the terrain on which the site lies, its surface geology, and its vegetation, its distance from the nearest town or village, and its height above sea-level.

The structural finds, such as earthworks, pits, ditches, and buildings, should be described in chronological order, beginning with the earliest.

It should be remembered that illustrations in the form of plans, sections, and photographs afford a far more vivid and economical medium of description than written text. In a well-planned report the text of this and the next section will to a large extent be ancillary to the illustrations, providing a commentary upon them rather than itself bearing the full burden of description.

4. *The discussion of the significance of the evidence.* It has

already been pointed out (p. 160) that no examination of archaeological evidence, however thorough, can ever yield anything but a working hypothesis, which remains 'true' only so long as and in so far as it explains the observed facts and does not conflict with the evidence of later discoveries. Not all the excavator's conclusions, however, are equally hypothetical; some will have more evidence in their support, others less. It is the duty of the excavator to distinguish these, and to make it clear which of his conclusions are almost certain, which probable, and which mere speculation or conjecture. Unless this is done, the reader, who has no access to the evidence otherwise than through the report itself, may be led grievously astray in assessing the results of the work.

The writer of the report will support his conclusions with citations of parallel evidence from other sites. It need hardly be said that the parallels quoted must be real parallels, and not merely superficial resemblances. For unfortunately not every reader of a report takes the trouble to look up the references quoted, and the relevance of the parallels given is too often taken upon trust.

Finally, it is once more repeated that the first duty of the excavator is to publish the *facts*; purely speculative considerations must take second place in the report, and for the sake of economy in space and expense should not be unduly elaborated.

5. *The Appendices.* Since the days of General Pitt-Rivers it has been the practice in excavation reports to describe all the objects found in appendices at the end, thus relieving the body of the text from tedious catalogues and making the detailed lists of finds more easily available for reference. These appendices will normally comprise all or some of the following classes of objects:

(*a*) Pottery.
(*b*) Glass.
(*c*) Stone tools.
(*d*) Small finds of metal.
(*e*) Small finds of bone, shale, wood, etc.
(*f*) Coins.

(*g*) Human remains.
(*h*) Animal remains.
(*i*) Samples of charcoal.
(*j*) Samples of soils.
(*k*) Samples of snail-shells.

The appendices on the pottery and the small finds of metal, bone, etc., will normally be the work of the excavator himself, who will also, if he has the special knowledge, report on the stone implements and other classes of finds. Usually, however, the more specialized appendices are the work of the experts to whom the excavator has submitted the material. Where this has been done the expert's report should be quoted in full; if this is impossible for reasons of space, a summary should be given with the name of the person responsible.

As far as possible all the pottery and small finds should be illustrated, and it is to these illustrations that the appendices should refer.

Pottery. The shape and size of the pot, the colour, texture, and surface of the fabric, the design and method of execution of any decoration, the find-spot, and the probable date should be given. When possible, references should be given to similar shapes and styles of decoration from other sites; these references should be to *specific* sherds or pots illustrated in previous publications; type numbers should not be used except in the case of *terra sigillata* ('Samian ware' of the Roman period). The following is a specimen of such a reference:

(4) Fragment of bowl, with slightly everted rim, diam. *c.* 4 ins. Hard, black, gritty ware, smooth surface decorated with burnished lines in rough lattice-pattern. Probably Iron Age *AB*. Trial Trench *A*2. Cf. *Victoria County History, Oxon.*, I (1939), 243, fig. 12, lower half.

On many sites the sherds found will be too numerous to illustrate them all, and a representative selection must be made for illustration and description in the appendix. In addition, the pottery as a whole can often be treated statistically with good results; the percentages of the various types of fabric,

shape, and decoration occurring on the site should be tabulated, as well as any changes in the relative frequency of occurrence of particular forms in successive stages of the occupation. Romano-British pottery, usually found in large quantities and in more or less standardized forms, is peculiarly fitted for such statistical analysis.

The pottery described in the appendix should be divided according to its period, beginning with the earliest. Romano-British pottery should be further subdivided under the headings 'Terra Sigillata' and 'Coarse Wares'; potters' stamps and any other inscriptions should also be listed separately.

Small finds of metal, bone, wood, etc. The material, shape, probable purpose, main dimensions, decoration and method of executing it, find-spot, and the probable date should be given. Parallels should be quoted where possible, as for pottery. Where the small finds are very numerous they should be split up under separate headings, such as 'Iron Objects', 'Beads', 'Fibulae', etc.

Stone tools. The main dimensions, probable purpose, method of working (i.e. flaking, polishing, boring), degree of wear, texture, colour and amount of patination, find-spot, and the probable date should be given. The statistical treatment of large quantities of flint implements can yield interesting results.

Coins. The size and metal, the design and inscription of obverse and reverse, the mint marks, and the degree of wear should be given. References should always be quoted to standard works on coinage (e.g. for Roman coins, Mattingly and Sydenham, *The Roman Imperial Coinage*); it is worse than useless merely to list the number of coins of each emperor found. As has already been said, coins are a difficult subject, and the interpretation of their evidence should be left to an expert numismatist.

Bones. With animal bones the name of the bone and of the animal, with its Latin designation, the find-spot, and the probable date should be given. Human remains should be the subject of a proper report from an expert physical anthropologist. Bones are not normally illustrated in a report.

THE PREPARATION OF THE TEXT

The actual method of preparing a written report is, of course, a matter of personal choice. There are, however, a few devices which can be usefully employed by any writer.

It will be found helpful to start by preparing the illustrations, or at least rough drafts of them. For, as has been said above, in a well-planned report the illustrations should bear the main burden of describing the site, and a part of the text at least will consist mainly of a commentary upon them.

The text must also be compactly and coherently arranged; a simple aid to achieving this is to write out the headings, sub-headings, and important points on small separate slips of paper. These may then be grouped together on a table to form a coherent and organized plan or framework for the text.

It is also most important that the text should be as short and concise as possible, for the sake alike of the reader and the publisher who bears the cost. It is a safe assumption that a report as first written will be needlessly long, and can be cut down by at least one-third of its original length, without omitting any of the subject-matter. This reduction can only be effected by constant revision of the text and determined 'pruning' of all unnecessary words and phrases; this can be done more effectively if the text is laid aside for some days between revisions, so that the words lose some of their familiarity. The more familiar the words are to their writer, the more difficult he will find it to judge correctly their relative importance and relevance to his subject.

Finally, it should be clearly understood that the cost of altering type, once it has been set up, is heavy, and chargeable to the publisher; it is therefore only fair that the writer of a report should take every care to see that his text as submitted to his editor is correct in every detail, and in its final form; the time to insert second thoughts is before, not after, the text has gone to press.

Figures, abbreviations, and references. It is to be regretted that at the time of writing there is no uniformity among archaeological journals in their manner of expressing figures in the text, of using abbreviations, and of quoting references.

Where one journal, for instance, has '2 *ft.* 6 *ins.*', '(*PLATE XV*)' and '*Cf. Antiquaries Journal*, vol. xi, p. 45', another will print '2′ 6″', '(*Pl. XV*)', and 'Cp. *Ant. Journ. XI*, 45'.

Under the existing circumstances the only safe rule to follow is to adopt the practice of the particular journal in which the report is to be published, as far as abbreviations are concerned.

There is, however, a standard method of quoting references to passages in books and journals, which should be strictly adhered to, even though it is not, unfortunately, followed by the editors of many archaeological publications. In the case of books, the reference should start with the surname of the author, followed by his initials; then the title, underlined, so that it will be printed in italics; then the edition (if there is more than one), the volume-number in Roman figures, and the date of publication in brackets; and finally the page number: e.g. Evans, J. *Ancient Stone Implements of Great Britain*, 2nd ed. (1897), 352.

In references to passages from periodical journals the author's name and the title of the article are omitted, and the reference consists of the title of the journal, abbreviated if necessary and underlined, followed by the series, if any, the volume-number in Roman figures, the date of publication, and the page number: e.g. *Arch. Camb.*, 6th ser., XX (1920), 102.

Where reference is made to a whole article, and not just to a passage in it, the author's name should be given, followed by the title between single quotation-marks, followed by the journal, series, volume and page references as before: e.g. Curwen, E. C. 'Neolithic Camps', *Antiquity*, IV (1930), 22–54. Note that pages are quoted as 42–9, 453–76, not 42–49, 453–476; this is preferable to writing 42 ff., 453 ff.

When the reference is to a figure, the page number should always be given as well, since in many journals figures are numbered from 1 upwards in each article, so that the reference 'Fig. 3' is not specific. In references to plates it is not usually necessary to give the page number, as plates are normally numbered consecutively throughout the volume.

References should never be taken from off-prints of separate articles from journals, as in some cases the pagination of the

off-print differs from that of the original (though this practice has now been abandoned by all reputable printers).

The abbreviations *loc. cit.* or *l.c.* (*loco citato*, in the passage already cited), *op. cit.* (*opere citato*, in the work already cited), and *ibid.* (*ibidem*, in the same place), are commonly used to avoid frequent repetition in references of the title of a book, article, or journal. They should be preceded by the name of the author concerned, and the last two followed where necessary by a page-reference.

The text should be carefully *typed* on single sheets of foolscap or quarto paper, in double spacing, and at least one carbon copy should be made. At either side a margin should be left at least one inch wide, in which the editor can add directions to the printer; and each page should be numbered. Words to be printed in italics should be underlined once, and those to appear in small capitals, twice. Footnotes, which will normally consist of references and subsidiary matter kept clear of the main argument of the text, should be typed at the bottom of the page to which they refer, beneath a line drawn right across the page, or on a separate sheet placed at the end of the text; in the latter case, the superscript reference numbers by which the footnotes are identified (which should be clearly indicated in the text itself) will run consecutively from 1 upwards right through the text.

Footnotes should be restricted to a necessary minimum because, being set up by a different compositor, they add to the total cost, and too many of them worry and delay the reader. On the other hand, it is essential that the fullest possible references should be given; nothing is more maddening to the reader, or more unscholarly, than the frequent mention of sites, objects, or pieces of research without any indication of where they are published.

References to the illustrations of the report, or to other matter which is to appear in the same volume, should be left blank, thus: (Fig.), (PLATE , 4), *v. supra* p. . A caret sign (∧) should be placed in the margin of the typescript opposite each such reference, to show the editor that the omission is intentional.

On a separate sheet the underlines for the illustrations should be typed. The underline should include the number of the figure or plate (this will, of course, be left blank in the first instance), a short description of the illustration with page references to the corresponding passage in the text, and any necessary acknowledgments; in addition, if the underline is for a plan or photograph of finds, it should contain a statement of the scale of reproduction:

viz. PLATE

A. The site from the North-West.
B. The Western defences from the South-West (see p.).

FIG.

Pottery from Kiln 3. (4th cent.)
Nos. 1–7 from the furnace-chamber (p.);
Nos. 8–24 from the stoke-hole floor (p.).
Scale: Nos, 6, 9, 11, $\frac{1}{2}$; the remainder, $\frac{1}{4}$.

A separate sheet should be fastened to the text and sheet of underlines, giving the name and address of the author and the number of words in the text. The latter may be calculated from the formula

$$N = A \times L \times P$$

where A = average number of words in a line.
L = average number of lines to a page.
P = number of pages.

Finally, it is once more urged that it is only fair to send in the report to the editor complete and correct to the last comma. Before sending it off, the text should be scrutinized once more for errors of spelling, punctuation, sense, and style; if possible, this should be done by a person other than the author to whom the text will be unfamiliar. All the references should be checked *with the original sources*.

PROOFS

Should the typescript be returned by the editor for alteration, the pages concerned should be typed out again, and the num-

bering of the pages altered if necessary. The original pages should be returned for comparison with the new copy.

When the printer receives the text he sets it up in type and prints off *galley-proofs*. These are strips of paper one page wide and 18 inches or more in length, on which the text is printed continuously, in its proper paragraphs, but without division into pages. Normally it is these proofs which the author will receive for correction, although some journals send nothing before page-proofs.

The proofs should be compared very carefully with the typescript, and all references should be checked once more *with the original sources*. All errors of spelling, punctuation, and type-setting should be noted, and marked and corrected in the margin opposite the line where they occur. At the same time the author should insert in the margin any fresh matter or alterations which he feels compelled to introduce into the text; these alterations are usually written in red ink, printer's errors in black, or vice versa.

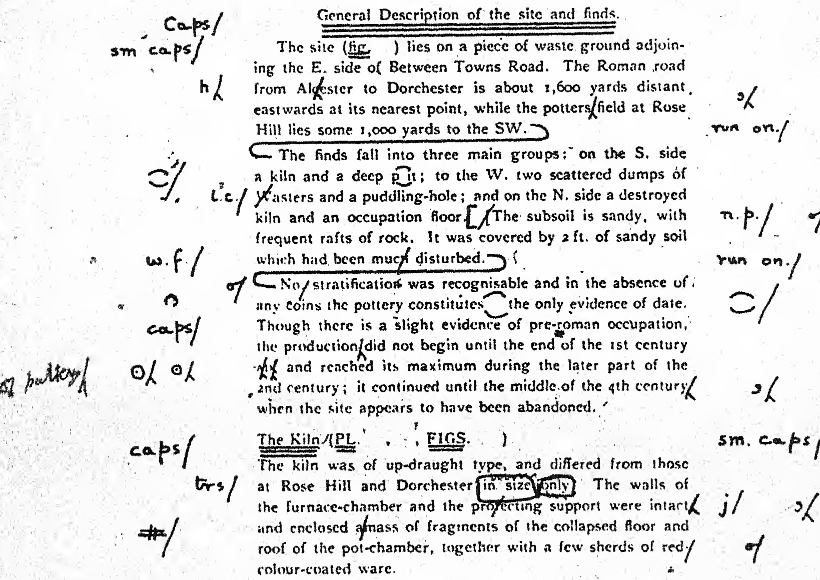
It should be clearly realized, however, that alterations by the author may involve the re-setting of many lines or even pages of type, for which the printer will charge accordingly; they should therefore not be made lightly. If alterations are essential, they should be written so as to occupy, as far as is possible, the same amount of space as the words which they replace.

The galley-proofs should be read and corrected by a second person, if possible, besides the author himself. When corrected, they should be returned to the editor. In due course the printer will send a second set of proofs, known as *page-proofs*. In these the text is set out exactly as it will finally appear, except that the page references will still be blank. These can now be filled in, as the correct page-numbers will now be available.

It is very bad practice to make any alterations to the text at this stage, beyond correcting any remaining printer's errors. If new matter *must* be added, owing, for instance, to the discovery of fresh material since the text was completed, it should be put in a note *at the end* of the report, where it will not interfere with the type already set up. Even in this case,

however, no more should be added than will fill up any vacant space. Alternatively, something else of equivalent length should be cut out *of the same page*.

Examples of the more common signs used in the correction of proofs are given in Fig. 66, which represents a galley-proof.


General Description of the site and finds.

The site (fig.) lies on a piece of waste ground adjoining the E. side of Between Towns Road. The Roman road from Alcester to Dorchester is about 1,600 yards distant eastwards at its nearest point, while the potters field at Rose Hill lies some 1,000 yards to the SW.

The finds fall into three main groups: on the S. side a kiln and a deep pit; to the W. two scattered dumps of Wasters and a puddling-hole; and on the N. side a destroyed kiln and an occupation floor. The subsoil is sandy, with frequent rafts of rock. It was covered by 2 ft. of sandy soil which had been much disturbed.

No stratification was recognisable and in the absence of any coins the pottery constitutes the only evidence of date. Though there is a slight evidence of pre-roman occupation, the production did not begin until the end of the 1st century and reached its maximum during the later part of the 2nd century; it continued until the middle of the 4th century when the site appears to have been abandoned.

The Kiln (PL. , FIGS.)

The kiln was of up-draught type, and differed from those at Rose Hill and Dorchester in size only. The walls of the furnace-chamber and the projecting support were intact and enclosed a mass of fragments of the collapsed floor and roof of the pot-chamber, together with a few sherds of red colour-coated ware.

Fig. 66

SPECIMEN GALLEY-PROOF, WITH ERRORS CORRECTED

The corrected text, as it would appear in page-proof, is shown in Fig. 67. This would be completed for press by the addition of the page references. It should be noted that the signs in the margin are all followed by an oblique stroke (/), which marks them off from each other and draws attention to them; and that all punctuation marks are surrounded by a small circle.

THE ILLUSTRATIONS OF THE REPORT

Attention has already been drawn to the value and impor-

tance of the illustrations. They provide a medium of description and record far more concise and more easily understood than many times the same amount of text, and if carefully planned will considerably lighten both the writer's and the reader's task.

It should be remembered, however, that illustrations are

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THE KILN (PL. , , FIGS.)

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Fig 67

SPECIMEN PAGE-PROOF, WITH THE CORRECTIONS SHOWN IN FIG. 66 INSERTED

expensive to produce, and the amount of space available for them in a report is limited. The archaeologist should therefore obtain from his editor an estimate of the space available for this purpose, and should make every effort to keep within the limits assigned.

The number and nature of the illustrations which are necessary will naturally vary according to the subject; the following list is given merely as a rough guide:

1. Map showing the relation of the site to the surrounding country.
2. Plan of the site.
3. Detailed plans of features of special interest.
4. Sections of important features.
5. Drawings of pottery and other small finds.
6. Photographs of the site, including air-photographs, and of sections, graves, and other features; photographs of finds. (It should be understood that photographs are the most expensive form of illustration, and should only be used to show details which cannot be conveyed by a line-drawing.)

Of these illustrations the most important are often the sections, which contain the stratigraphical evidence from which the history of the site is interpreted. It should never be forgotten that the published plans and drawings constitute the only records of discoveries which in many cases cannot be later independently confirmed. The accuracy of these records cannot be checked by the reader of the report, who is compelled to accept upon trust their correspondence with the true facts. One of the excavator's chief responsibilities, therefore, is to assure himself of the accuracy and objectivity of his illustrations.

Illustrations are produced by two methods. The *half-tone* process is used for the reproduction of photographs, and is familiar to every one as the method of making pictures in the newspapers. The image of the photograph is split up into small dots of varying size, the areas where the dots are largest and closest corresponding to the dark parts of the photograph. These dots are then transferred to a copper printing-block. In order to obtain good definition half-tone illustrations are normally printed on special paper, heavier and more expensive than that used for the text.

Photographs for reproduction by this process should be printed on glazed glossy bromide paper giving neutral black or blue-black tones; warm-tone or sepia prints are unsuitable. The print should be of good contrast and definition, without noticeable grain. Over-exposure of the print and excessive contrast

must be avoided at all costs. It is a mistake to suppose that the splitting up of the image into fine dots in the process of reproduction will mask noticeable graininess or imperfect definition.

The linear dimensions of the print should not be less than those of the proposed block, and should for preference be from 50% to 200% greater. Where several prints are to be reduced to the same degree they should all have, if possible, approximately the same range of density and contrast.

If possible, irrelevant parts of the image should be cut off, so that unwanted details such as wheelbarrows, tools, and the feet of bystanders are not included. If the print cannot be cut up, the parts to be cut off should be outlined with a soft pencil either on a sheet of tracing paper gummed to the top edge of the back of the print and folded over to cover the front, or, less satisfactorily, on the back of the print itself. In either case great care must be taken to avoid indenting the glazed surface of the print by undue pressure on the pencil. For the same reason, prints should never be fastened together with paper-clips; the best method of sending them through the post is to fasten them with rubber bands between two pieces of stiff card of slightly larger size.

The suggested *linear* reduction should be clearly indicated: e.g. 'reduce $\times$ $\frac{1}{2}$ in.' This means that from a print measuring 6×8 in. a block 3×4 in. is to be made.

White lines and spots on the print, due to imperfections in the negative, should be touched out with one of the neutral black dyes sold for this purpose, suitably diluted. The same dyes may be used to bring out important details, so long as the effect is merely to emphasize, and not to distort or falsify, the evidence of the photograph; but such retouching requires care, and is best avoided by the inexperienced. Special features can also be outlined or lettered on the print in 'Process' white or Indian ink. Prints that have been crumpled or cracked on the surface may usually be restored by re-glazing them.

The *line-block* process is used for reproducing maps, plans, sections, and drawings of pottery and small finds; the drawings are made on white paper in black ink lines, and these are transferred by a photo-chemical process to a zinc printing-block,

on which they stand out as raised ridges. Line-blocks are usually printed on the same paper as the text.

LINE DRAWINGS

The image to be transferred to the line-block should be large enough to permit of reduction by the block-maker to at least half the linear size of the original drawing. In this way the lines are sharpened, raggedness removed, and the general appearance of the drawing improved. The size at which the original must be drawn will therefore depend upon the size of the proposed block.

Normally, no illustration should be wider or taller than the space occupied by a page of text; projections beyond these limits should be kept to a minimum, as some blank margin must always be left to allow for trimming by the binder.

In extreme cases, where the drawing is too large and too detailed to be compressed by reduction into the limits of a single page, it must be printed on a folder. It is cheaper and more convenient if the folder is not taller than the page when unfolded, so that the folds need be made in one direction only; but in any case such folders are expensive and should be avoided if possible.

In choosing the size of his drawings, the draughtsman is influenced by three considerations; namely, the nature of the detail to be shown, the scale of the final drawing, and the cost of the block. It will be clear that the process of reduction enables detail to be printed in lines far finer than can be drawn with a pen at the same size. Thus, when close, fine detail is to be shown, the drawing should be made at a large scale, say, four times the linear size of the proposed block. Reduction of this degree, however, involves certain difficulties in drawing, which are considered later. Where, therefore, the detail is not particularly fine, a drawing two or three times the size of the proposed block will be adequate.

Secondly, it is always desirable that the scale of maps, sections, and plans *when printed* should be a fairly simple one, either 1 *inch to* $10n$ *feet* or 1 inch to 2^n feet (where n is any

whole number). This will facilitate comparison of plans drawn at different scales. Hence the degree of reduction should be one which will not produce an awkward scale in the printed plan.

Lastly, there is the ever-present consideration of expense. The cost of line-blocks is calculated by their *area*; hence an increase to twice the linear size of a block means an increase of four times in the cost. Obviously, therefore, blocks must not be needlessly large. On the other hand, there is no point in cramping every line-drawing into the smallest possible space, since most block-makers make a minimum charge for all blocks up to a certain size (usually about 14 square inches).

Of these three considerations the first is the most important, for clearly no drawings will be satisfactory if when reduced the detail is so cramped as to be unrecognizable.

MAPS

The 25-inch and 6-inch Ordnance Survey plans can often be used as a basis for archaeological maps, the detail being inked in directly on to them. When reduced, however, these maps have rather a spidery appearance; a better method is to trace the map, or re-draw it at a larger or smaller scale, and add the detail to the tracing. The whole drawing will then be uniform and from the same hand (for the method of enlarging and reducing a map, see p. 204).

Maps should always be marked with a scale of yards or feet and the direction of *True* North; as far as possible the north should be at the top of the map. If they are based on the Ordnance Survey maps the editor of the journal should be informed, for he will have to obtain permission to reproduce them from the Director-General of the Survey; an acknowledgment of the permission should be printed in the underline.

PLANS

All plans should bear a scale of feet and the direction of *True* North. If two or more plans cover wholly or in part the same piece of ground, they should be drawn in the same orientation (i.e. with the north arrow pointing in the same direction

relative to the page); as before, where possible the north should be at the top of the page.

The position of all sections mentioned or illustrated in the report *must* be marked on the plan on which they occur. The lettering of these positions on the plan must correspond with the lettering of the ends of the section drawings themselves.

Conventional mapping signs and methods of representing archaeological detail are described below (p. 199).

SECTIONS

The drawing of sections constitutes one of the chief problems in the presentation of archaeological evidence, and the variety of methods employed by different archaeologists in the British Isles and abroad reflects wide divergencies of opinion concerning the best conventions to adopt. At one extreme is what may be called the 'naturalistic' school, which attempts to represent as faithfully as possible what is actually seen in the section, or would be recorded in a photograph of it; at the other is the 'diagrammatic' school, in which the visible details are simplified and interpreted in the drawing, and represented by purely conventional symbols. Between these two extremes lies a variety of practice in which these tendencies mingle in different proportions.

Sections drawn in the 'naturalistic' manner are frequently very difficult to understand, because they attempt to reproduce in ink lines and dots what can in fact be objectively reproduced only by the continuous tones of a photograph; such drawings, at their worst, merely sacrifice clarity for the sake of a spurious and illusory objectivity. It is an inescapable fact that any drawing must be subjective, and must contain elements of selection and simplification; but this in no way invalidates the status of a drawing as a piece of evidence, provided that the selection and simplification are confined to separating the essential characteristics of the section from the incidental ones. There is no virtue in reproducing a section in all its *minute* details, even if this could be done without loss of clarity, since these details vary sensibly from one plane of section to another separated from it by only a few inches.

On the other hand, the purely diagrammatic drawing is frequently misleading, since it may give an erroneous impression of homogeneity in individual layers, and of the sharpness of the boundary between one layer and the next.

For these reasons the divisions between the component layers of a section should be indicated by solid lines only where the division is really sharp, or where there is a clear horizon separating two stages of the cultural history of the site.

The method of representing various types of deposit will depend upon the nature of the individual sections. Structural stone-work must, of course, be drawn to scale, and the coarser materials, such as chalk or rock rubble, and gravels, should be indicated in a fairly naturalistic manner, to give an idea of the grading of size and the degree of their angularity. Finer deposits, however, consisting of sand, loam, soil and clay, and mixtures of these, can only be represented diagrammatically by means of simple hatchings and stipplings; examples are given in Fig. 72.

Fig. 68 shows four sections through roughly similar structures on chalk, gravel, rock and clay subsoils. They are not offered as models of what sectional drawings should be, but merely as examples of conventions suited to these particular structures and materials.

In sections consisting mainly or entirely of fine-grained layers, which must be represented conventionally, much care is needed in the choice of suitable hatchings; an excellent example of the use and abuse of hatchings is given in *Ancient India*, III (1947), 143–50.

Borders. All maps and plans should be enclosed in a border. A plain single line is sufficient; ornamental borders are not suitable, except for plans of a decorative character.

Whether or not to surround a page of sections with a border is a matter of taste; a plain bold border certainly gives a more finished appearance, especially when the sections are of different lengths.

Borders are not usually drawn round illustrations of pottery and other small finds.

PROBLEMS INVOLVED IN REDUCTION

The reduction of a drawing to make a block reduces all parts of it, including the thickness of the lines. The limit to the fineness of line which can be printed from a block is of the order of 1/300 inch, but such lines give a spidery appearance to the drawing, so that the practical limit is about 1/200 inch. Hence, the width of the finest line on a drawing must not be less than $1/200 \times 1/n$ inch, where n is the proposed degree of reduction. Thus, if a drawing is to be reduced to one-quarter on the block, the finest line should not be thinner than 1/50 inch.

The same rule applies to the lettering of drawings. Lettering which is perfectly legible on the original drawing may be quite unreadable on the block, unless the degree of reduction is taken into consideration in choosing the size of the letters. A good idea of the appearance and legibility of the printed plan may be obtained by viewing the original drawing through a reducing (negative) lens.

For the same reason care should be taken in executing hatching or stippling to keep the lines and dots far enough apart. Stippling in particular is liable to print very faintly, unless it is drawn rather heavier than seems right in the original drawing.

LETTERING

Lettering is the most difficult part of map drawing, and bad lettering will quite destroy the appearance of an otherwise well-executed plan. If the archaeologist is not able to letter his own drawings competently by any of the methods described below, he should entrust this part of the work to a professional penman, or write it in pencil and ask the editor to have proper lettering added.

An enormous variety exists in styles of lettering, but many of them are not suitable for this purpose. Nor should it be thought that there is one best style, which can be used universally for all kinds of maps and plans. Apart from the fact that different styles should be used to indicate different features on the same map (e.g. archaeological features and names in one style, modern names in another) the style of lettering chosen

must accord with the general character of the drawing. Formal functional maps and plans, similar in character to the large-scale plans of the Ordnance Survey, require a formal style of lettering; a much more cursive style, however, should be used on plans which aim at being decorative as well as functional (such as the admirable work of the late Mr. Heywood Sumner).

Two different styles of lettering which are suitable for maps and plans are shown in Fig. 69. The formal italic alphabet is by far the most elegant, but its execution free-hand is beyond the capabilities of the amateur letterer. It is possible, however, to reproduce this style by careful tracing from a printed alphabet, although great pains must be taken to keep the slope and alignment of the letters uniform. It is not necessary that the whole drawing should be on tracing-paper; the lettering can be traced separately and pasted in place afterwards; the *montage* will not show in the printed drawing.

The second style, known as 'round-hand', is executed with special pens, the thick and thin elements being produced naturally by the movement of the hand. Considerable practice is needed to acquire a neat and legible hand. Only the simplest letter-forms should be attempted; ornamental styles, such as the various 'Gothic' alphabets, are difficult to execute effectively, and are in any case out of place in map work.

Very simple, though by no means beautiful, lettering can be executed with ease by means of special celluloid stencils, supplied by stationers under the names 'Uno' and 'Multigraph'. Both the Roman and Italic forms are available. The lettering of the figures in this book was executed with these stencils.

It is fairly easy to imitate free-hand the simple sans serif alphabets of these stencil outfits, and this method may be preferred by those who dislike the latter's somewhat dull and mechanical appearance. It is best to use a firm nib which will not easily spread, with a fairly broad point. A fine point, like that of a mapping-pen, produces spidery, inelegant letters, and easily pierces the paper and gives a ragged line.

For all lettering parallel lines should be drawn in pencil as a guide, and short vertical (or for italics, oblique) lines should

be ruled at frequent intervals to keep the slope of the uprights uniform. The best slope for italic letters is about 10° from the vertical.

The three chief faults in amateur lettering are bad spacing, wrong size of letters, and misuse of capitals. In spacing, it must be remembered that not all the letters are of the same width; the letter I, for instance, occupies much less space than M or W. It is the *white areas* between adjoining letters, not the spaces occupied by the letters themselves, which should be equalized. Normally the greatest space should occur between letters with parallel elements (ND, AV); there should be less space where an upright adjoins a curve (IO, NC); and least space of all where two curves come together (OO, DG). Secondly, it is often forgotten that the drawing must be reduced by the block-maker for printing; lettering which is legible on the original may not be so when reduced, especially if it was rather cramped in the first place. In choosing the size of lettering, due allowance must therefore always be made for reduction. Finally, it should be noted that where whole words are written in capitals, all the letters should be of equal height. The use of larger initial letters in such a case is a typographical abomination.

DRAWING POTTERY

Certain methods of drawing pottery have become almost standardized among archaeologists.

Single sherds are drawn as in Fig. 70, each with its section in black, usually at the left-hand side. The drawing may be done either in stippling or hatching; in either case the aim should be to show all the details of the shape and decoration clearly, and to indicate the texture of the pottery. To draw pottery by either of these methods requires skill and practice, but much help can be gained from careful study of published drawings under a magnifying-glass.

Single sherds of Roman pottery are usually drawn in section only, unless they are decorated. In this case it is usual to indicate the decoration only in line, without a ground-work of stippling or hatching (Fig. 71), since the latter cannot adequately represent the smooth surface of Roman wares.

THE FORM Q IS PREFERABLE TO THAT SHOWN

ABCDEFGHIJKL *ABCDEFGHIJKL*

MNOPQRSTUV *MNOPQRSTUV*

WXYZ *abcdefg* *WXYZ* *abcdefgh*

ijklmnopqrstuvwxyz *ijklmnopqrstuvwxyz*

1234567890 1 2 3 4 5 6 7 8 9

Fig. 69

Single sherds are usually drawn at full size, and are reduced to one-quarter or one-half on the block.

Whole vessels, and those of which enough sherds are present to make possible a full reconstruction of the shape, are usually illustrated by a different technique. The drawing is divided by a central vertical line (Fig. 71). On the *left* of this the section is drawn at the correct distance, together with any

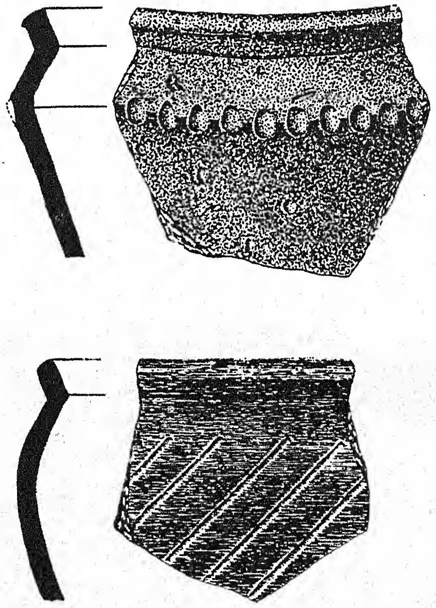


Fig. 70

decoration on the *inside* of the pot; on the right is shown the profile, and any decoration on the *outside*. For prehistoric and other rough pottery the right-hand portion is usually hatched or stippled, as in drawing single sherds, and for Roman pottery only the form of decoration is shown, as before.

Restored portions of a section or a decorative pattern should be indicated by broken lines; care should of course be taken that no restoration is shown unless it is the only one possible.

Pots up to 9 inches or 1 foot in height can usually be drawn full size, and reduced on the block to one-quarter or even one-sixth. Larger pots should be drawn at a reduced scale in the first place, and reduced still further on the block. The original drawing, however, should not be less than twice the size of the proposed block.

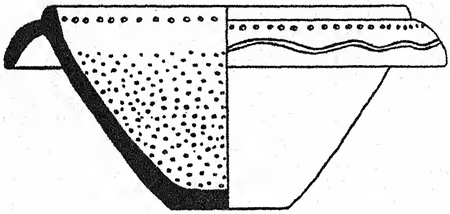


Fig 71

Pottery sections. Three methods of plotting the vertical sections of sherds and whole pots are in general use.

1. *By eye.* The main measurements of the pot are taken (i.e. the diameter at the rim, base, and one or more intermediate points, and the height). These are plotted on drawing-paper and the remainder of the outline is drawn in by eye. This method is suitable only for whole pots of fairly simple form.

2. *With flexible wire.* This method makes use of a length of soft, flexible metal wire. The best material is 40-ampere electrical fuse-wire (tin alloy), and the lead wire used for tying garden labels is also suitable; copper or iron wire is too springy.

The wire is straightened and pressed with the fingers against the side of the pot in a vertical line from rim to base, being turned over at these points for a short distance, to mark their position. It will be found that the wire is soft enough to be fitted into all but the smallest overhangs and indentations, but is yet sufficiently firm to retain the shape of the profile when it is removed from contact with the pot.

3. *With an L-square.* The pot is laid on its side on a piece of drawing-paper, and is tilted until the base is vertical when tested with an L-square. The square should be of metal, of the type used by engineers, and capable of standing vertically on its shorter, thicker side.

The pot is wedged and supported in this position by lumps of plasticine placed beneath it. The square is then moved until the vertical arm touches the rim and a dot is marked with a pencil where the arm meets the paper. This process is repeated at small intervals down the side of the pot, round the base, and up the other side to the rim, at a point diametrically opposite to the starting-place. In this way the profile of the pot is projected vertically downwards on to the paper.

This method, for which I am indebted to Mr. W. F. Grimes, is particularly suited for drawing hand-made prehistoric pots, in which the shape of the sides is often far from uniform all round the vessel.

In drawing rim-sherds, care should be taken that the section is shown in its correct position relative to the horizontal, with the sides at the proper slope. To find this position the sherd is held with the rim touching the under-side of a flat surface, such as a drawing-board, and is rocked to and fro until the rim is in contact with the board at every point.

Whenever possible the diameter of a pot should be given, either in the drawing or in figures in the text, even when only a small sherd is illustrated. The diameter can be found by taking a horizontal profile with wire, and fitting this over a series of concentric circles drawn at intervals of $\frac{1}{4}$ inch.

Any number of sherds up to about thirty can be illustrated in a full-page line-block, according to their size and the degree of reduction. It is inadvisable to make all the drawings on the same sheet of paper, as an accident with the ink-bottle may ruin them all; it is better to draw each sherd separately on small pieces of paper, and afterwards to paste these in their correct positions on a sheet of white cartridge paper.

Each sherd or pot must be numbered to facilitate reference from the text; where a large number of sherds are shown, so

that they fill more than one page, they should be numbered consecutively throughout.

Before sending finished sheets of drawings to the editor or block-maker all pencil lines should be rubbed out, and the suggested degree of reduction written at the bottom.

HATCHING, STIPPLING, AND CONVENTIONAL SIGNS

Examples of the more common methods of hatching and

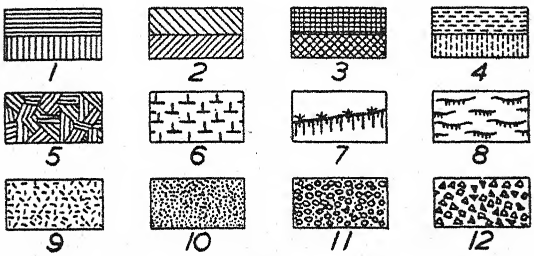


Fig. 72

1, 2. Uniform, compact layers. 3. Hard, compact layers, such as floors. 4. Looser layers. 5. Clay or loam. 6. Undisturbed chalk or limestone rock. 7. Modern surface. 8. Turf constructions. 9. Loose, sandy silting. 10. Sand. 11. Gravel. 12. Rubble.

stippling used to distinguish the layers of sections are given in Fig. 72, together with suggestions of the type of material that they may best be used to represent. Plain stippling of dots may also be used on plans, to mark the area covered by a particular feature. If desired, this can be inserted on the plan by the block-maker, instead of being drawn laboriously by hand.

Sharp slopes on the surface of the ground, such as the sides of barrows and banks, ditches and lynchets (cultivation terraces), are usually indicated by hachures (Fig. 73). It should be noticed that the hachure follows the slope from top to bottom, at right angles to its crest, the wide end of the hachure being always at the top. On small-scale plans, where there is no room to insert hachures at the correct scale, a ditch and bank is

represented by a thin and thick line, parallel and close to each other, the *thick* line always representing *the bank* (Fig. 74).

Excavated slopes, such as the sides of pits and ditches, are indicated by a special type of broken hachuring (Fig. 75).

Fig. 73

Fig. 74

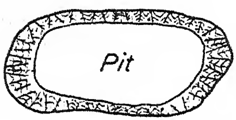


Fig. 75

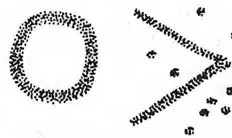


Fig. 76

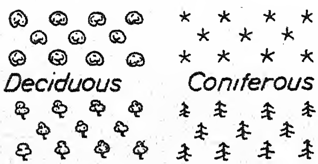


Fig. 77

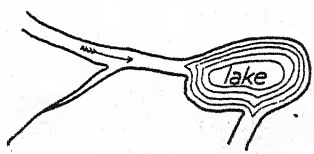


Fig. 78

Other conventional signs used to represent modern features are shown in Figs. 76–8. It should be noted that a distinction is made between coniferous and deciduous trees, and that the direction of flow of streams and rivers is indicated by a small arrow. Archaeological features which are known only from air-photographs should be shown in a different manner from those visible on the ground; the most convenient method is by stippling (Fig. 76).

DRAWING INSTRUMENTS AND THEIR USE

Drawing-board. Any flat wooden board can be used, but it is better to have a proper board with straight edges and right-angled corners, as it is only with these that the T-square can

made in the field, and are thus most conveniently executed on tracing-paper. *Tracing-paper* should be of good quality (preferably made from rag-fibre), white in colour, with a smooth surface. *Tracing-linen*, a light-blue translucent cloth, is more durable, but also more expensive. The drawing is done on the matt side which should be previously rubbed over with French chalk and dusted clean to remove grease. By far the most satisfactory, though not the cheapest, tracing material is a thin light-blue plastic sheet known as *Ethulon*; this has a matt surface on one side, which takes ink admirably; the material is much more transparent than tracing-paper or linen, and if rubbed briskly with the hand or an eraser will adhere closely to the sheet on which it is placed. It is particularly useful for tracing detail from air-photographs, and if this is done in pencil and afterwards rubbed out, the same sheet can be re-used indefinitely.

Pens. For straight lines the *ruling-pen* should be used; this enables lines to be ruled of even thickness along a straight edge, without the ink running underneath and blotting, as happens with an ordinary writing-pen.

The nib of the ruling-pen consists of two opposed tapering tongues of springy metal, with a narrow space between them; the distance between the points can be regulated by means of a milled nut to give lines of any thickness. The better types of pen have one tongue hinged, so that it can be swung out for cleaning the inner surfaces of the points.

To use the pen, a drop of ink is taken up on the quill of the ink-bottle, and carefully allowed to run between the points of the pen, which should be filled for not more than a quarter of an inch. The pen is then drawn in an upright position along the straight edge. The upright position should be maintained, as if the pen slopes towards the ruling-edge the ink may run beneath it.

Although designed chiefly for straight lines, the ruling-pen can also be used for drawing curves, if these are not too abrupt. Where the line is very irregular, it is better to use a ball-pointed nib, or one of the special pens made for use with the 'Uno' stencils. These have a tubular nib which gives lines of even thickness round the sharpest curves.

be employed. In use the board should be inclined at an angle, either resting on a specially inclined drawing-desk or propped on a flat table with books; the most convenient angle must be found by experiment; it is usually about 30° from the horizontal.

The paper should be fixed with its edges parallel to the edges of the board, and held down with drawing-pins pushed right home, or with strips of adhesive paper or tape. As the hands must rest on the paper during work, it is wise to cover those parts of the drawing which are not being worked upon by long strips of tracing or other paper stretched across and pinned to the under-side of the board.

Ink. Drawings should be executed in indian ink only; ordinary writing inks are not suitable. Indian ink can be obtained in bottles fitted with a quill in the cork, which is used to fill the pens (q.v.); it evaporates easily and thickens if exposed to the air too long, and the bottle should therefore be kept tightly corked when not in use. The ink dries hard and waterproof, and cannot be removed satisfactorily with an eraser. Mistakes should therefore be left until the drawing is finished, and then carefully inked out with thick opaque white ink. For this purpose 'Process' white should be used, as the more common Chinese white, though similar in appearance, tends to photograph as grey, and does not entirely conceal the mistakes on the block.

A bottle of ink may easily be overturned by a careless movement of the arm, and nothing is more mortifying than to ruin a just-completed drawing in this way. The bottle should therefore always be placed in a block of wood or lead heavy enough not to be easily upset, and pens or brushes should never be left standing in the bottle where they may catch the hand.

Paper. Drawings for reproduction as line-blocks may be made on a variety of surfaces. *Cartridge paper* should be of good quality, with a smooth surface; the best surface is obtainable on *Bristol Board*, but this is expensive. *Squared* paper can be used, provided that the rulings are in faint blue, which will not register in the process of block-making. Most drawings, particularly those of plans and sections, are copies of working-drawings

Other ruling-pens are made in which the plain points are replaced by small toothed wheels. These enable broken and dotted lines to be drawn very neatly, but unfortunately they are too fine to reproduce well unless worked over a second time with an ordinary pen, and this process removes much of their neat appearance.

Parallel lines to represent roads, etc., can be drawn with a '*Script*' *pen*; this resembles two ordinary writing-nibs joined together with the two points a short distance apart. A special ruling-pen with two nibs, known as a 'road pen', can also be obtained.

The ordinary mapping-pen may be used for small detail such as trees and conventional signs, but care must be taken to use a gentle even pressure, so that the points do not spread and pinch or pierce the paper. Equally fine but less scratchy pens are Gillott's 404 EF, 303 EF, and 292 EF.

Set-square. This instrument enables vertical and diagonal lines to be ruled parallel to one another, and is therefore much used for executing hatchings. The celluloid type enables the work to be seen all the time. In use, the T-square is fixed in position and clamped (see below), and the set-square is slid from side to side along the straight edge into any required position.

T-square. The square should be made of good wood, free from flaws, with a bevelled ruling-edge made of ebony. In use, the head of the T is placed in contact with the left-hand edge of the drawing-board, which should for preference also be fitted with an ebony straight-edge, and the square can then be slid up and down into any required position, the left hand supporting the square and the right hand holding the pen.

When it is required to have both hands free, the T-square may be clamped in position with a large 'bull-dog' clip, or with a special clamp fitted permanently to the square, which can be obtained from the makers of the 'Uno' lettering stencils (p. 193).

A strip of very thin baize may be glued to the under-side of the stem of the square, to raise the edge slightly above the paper and prevent ink from running beneath it and blotting.

Needless to say, the square should never be slid about on the paper when the ink is still wet.

The T-square should *never* be used as a straight-edge for cutting paper with a knife or razor-blade, as sooner or later a shaving will be cut from the edge, ruining it for ruling purposes.

When not in use the square should be hung on a nail through the hole at the end of the stem; if it is leant against the wall, especially in the sun, it may warp.

The straightness of the ruling edge should be tested by ruling a long line, turning the square round, and ruling a second line very close and parallel to it, in the opposite direction. Any waviness of the edge will immediately be apparent.

THE ENLARGEMENT AND REDUCTION OF PLANS

It will often be necessary to re-draw a plan made in the field at a different scale, for the purposes of publication. It is usually easier to do this by working from the original noted figures, but if these have not been recorded the following method should be used.

The plan which is to be copied at a new scale is covered by a grid of horizontal and vertical lines at equal intervals, which are suitably lettered or numbered at the margin. Normally the interval between the lines should not exceed 1 inch, and where there is much detail to be copied it should be reduced to ½ inch, or even less.

A second grid of lines is now drawn on a clean sheet of paper (if tracing-paper is used for the new plan it can be placed over a grid drawn separately, and thus kept clean); the distance between the lines of this second grid will depend upon the scale at which the plan is to be copied. For instance, if the first grid is a ½-inch one, and the copy is to be three times as large as the original, the lines of the second grid must be 1½ inches apart; if the first grid is a 1-inch one, and a reduction to one-half is intended, the second grid must be ruled in ½-inch squares.

When both grids have been prepared, the detail is transferred to the new plan, using corresponding lines as references, and

scaling off any required measurements with a pair of proportional dividers set to the correct ratio.

The *enlargement* of plans by the above method is to be avoided where accuracy is required, as any errors in the original will be increased in proportion. The same objection does not apply, of course, to the process of reduction.

ISOMETRIC DRAWINGS

In addition to plans and sections, it may sometimes be desirable to show the three-dimensional aspect of an excavated site, or of a conjectural reconstruction of it. The most convenient way of doing this is by an isometric drawing; this resembles superficially a perspective sketch, but has the advantages that it can be more easily constructed than a true perspective from the data of plans and sections, and that measurements can be scaled off from it directly.

To make an isometric drawing, two axes at right-angles are drawn on two adjacent sides of the ground-plan (Fig. 79, OX, OY); for convenience the axis OX should run in the direction of the longest diameter of the site, and parallel to the main longitudinal section; if the site includes a rectangular grid of trenches, or a rectangular building of importance, the axes should be parallel to their sides.

On the sheet for the isometric drawing three axes are drawn (Fig. 79, O′X′, O′Y′, O′Z′), of which the last is vertical and the other two inclined at 60° to it, one on each side; these axes are then scaled off in equal units. To fix the position of any point P which appears in the plan and sections, its co-ordinates in the horizontal plane, x, y, are measured from the axes on the plan, and its height z above the datum plane of the sections. These co-ordinates are then plotted on the isometric scale as x′, y′ and z′, parallel to their respective axes (Fig. 79); in this way, by plotting a number of key points, the isometric sketch is gradually build up. Fig 79 shows an isometric drawing based on the plan and section given in Fig. 14.

Axes and co-ordinates for isometric sketches can conveniently be plotted with a 60° set-square; an even simpler method is to use isometric graph-paper, on which a grid of lines is printed at the correct angles.

It will be clear that measurements taken on an isometric drawing parallel to the isometric axes (which should be indicated and scaled at the bottom of the sheet) can be read off directly, though angles in the horizontal and vertical planes will be

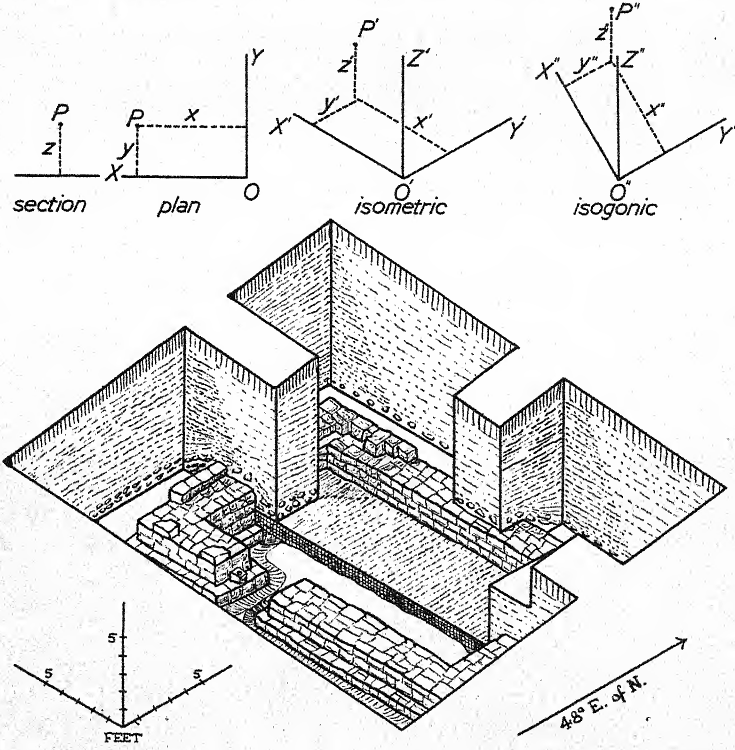


Fig. 79

distorted. By plotting the horizontal axes at right-angles (Fig. 79, O″X″, O″Y″) an *isogonic* drawing can be constructed, in which angles in the horizontal plane, as well as distances parallel to all three axes, can be scaled off directly. This method, however, tends to exaggerate the apparent height of structures, and is less suitable than isometric drawing for purposes of illustration.

GLOSSARY OF ARCHAEOLOGICAL TERMS

Terms chiefly used in surveying are marked (S).

Angle of elevation or depression (S)

At any point the angle of elevation or depression of another point is the angle between the horizontal and the line of sight between the two points.

Angle of rest

The angle relative to the horizontal at which soil, gravel, sand, chalk rubble, etc., comes to rest when dislodged. When this angle is reached no further silting takes place. The angle of rest varies with the type of material, being greatest for wet clay and least for dry sand; the mean figure for all types is about 33°.

Back-bearing (S)

The back-bearing of any line *AB* is equal to the bearing of *A* from *B*. The back-bearing and the forward-bearing of the same line always differ by 180°

Base line (S)

Any arbitrary line on the ground from which detail is measured and plotted, either by offsets (q.v.) along its length or by measurements of direction or distance from points on it.

Baulk (*Balk*)

A narrow portion of unexcavated ground separating two cuttings. Long narrow baulks are sometimes known as 'keys'.

Bearing (S)

The bearing[1] of the line joining two points is the angular distance between that line and the direction of North. Bearings are always measured in a clockwise direction, and are known as True or Magnetic Bearings according as they are measured with reference to True or Magnetic North (q.v.); all bearings measured with the compass are magnetic.

A bearing may have any value up to 360°. Thus 90° is East, 180° South, 270° West, and 0° or 360° North. A bearing of 450° is East (i.e., a full circle of 360° plus 90°).

[1] Strictly speaking, this should be known as an 'azimuth'. The word 'bearing', however, though technically incorrect, is more commonly used, at least among laymen.

Bench mark (S)

Official marks set up by the Ordnance Survey to show heights in feet above Ordnance Datum (q.v.). The mark is shaped like a broad arrow meeting a short horizontal line at its point; this line is at the given height. The marks are cut into the cornerstones of buildings, gate-posts, and other such permanent objects or upon special concrete blocks set in the ground. The position of bench marks is marked on the large-scale plans of the Ordnance Survey by a broad arrow and the letters B.M. followed by the height in feet above Ordnance Datum.

Contour (S)

An imaginary line passing through all points on the ground of a given height above a given plane. Unless otherwise stated this plane is taken to be the Ordnance Datum. Contours are the principal means of showing the third dimension, height, on a two-dimensional map.

Cutting

An intentional excavation of any shape.

Datum line (S)

Any horizontal line of reference from which vertical measurements are made (e.g. in drawing sections, p. 121).

'*Dried peas*'

See p. 56.

Filling

Sensu lato, the material occupying any natural or artificial depression. *Sensu stricto*, material intentionally thrown in to fill up a ditch or pit, as distinct from silt (q.v.).

Find

Discoveries or 'finds' on an archaeological site may be divided into two classes: (1) *Structures*, either excavated from the natural subsoil, like ditches, pits, and post-holes, or firmly rooted in the ground, like walls, floors, and timbers. (2) *Objects* which are movable, such as tools, weapons, and ornaments, and human and animal remains.

Find-spot

See *Provenance*

Horizon

Any level in a stratified site to which a particular cultural or

chronological label is assigned (e.g. the Iron Age A2 horizon, the fourth-century horizon).

Keys

See *Baulk*

Made soil or 'make-up'

Soil or other material intentionally laid down by human agency, as distinct from silt (q.v.) and other natural deposits.

Magnetic variation (S)

The angular distance between the directions of True and Magnetic North at any given place and time. The magnetic variation at Greenwich is given each year in *Whitaker's Almanack*, and may be found for any district of the British Isles in the left-hand margin of the O.S. 1″ map of that district. The variation given is that of the year in which the map was published, but a note is added of the average annual decrease in the variation, which enables it to be calculated for any subsequent year with sufficient accuracy, provided that the map is a fairly recent one.

Once the magnetic variation at any place is known the direction of True North may be found. Thus, if the variation is 12° West, True North will be 12° *East* of the Magnetic North given by an accurate compass.

Natural rock or 'natural'

The undisturbed material upon which the soil lies. The term includes softer materials, such as sand, clay, gravel, and peat, as well as rocks in the more common sense, such as chalk and limestone.

North (S)

1. *True North.* The direction of True North at any point on the earth's surface lies on the shortest line joining that point to the North Pole. It is a convention in mapping that North should always be at the top of the map unless otherwise stated. This holds good for all the maps of the Ordnance Survey. The direction of True North should always be shown on archaeological maps and plans.

2. *Magnetic North.* The direction of Magnetic North at any point on the earth's surface is given by a free-swinging magnetic needle which is not influenced by local magnetic attraction. The direction of Magnetic North varies at different places, and also at the same place at different times; it is because of this variation that True North, which is invariable, should always be marked on maps.

3. *Compass North.* The direction of North shown by any parti-

cular compass. This may differ from Magnetic North if the compass is inaccurately adjusted. A method of finding the variation of a compass is given on p. 135.

Object

See *Find*

Offset (S)

A measurement made perpendicular to a base line (q.v.) at any point along its length.

Old Turf Line

A band of soil, usually dark in colour, representing a turf-grown surface at some earlier stage in the history of a site. They occur beneath barrows, banks, and other earthworks, and in silted ditches which have later been filled up (Plate VIII).

Ordnance Datum (*O.D.*) (S)

The name given to the datum plane from which all heights are measured on the Ordnance Survey maps. The old Datum was fixed at Mean Sea Level at Liverpool Docks. The levelling of the Ordnance Survey maps is now being revised, however, with reference to a new Datum at Newlyn, and most of the 6-in. plans have a note at the bottom stating to which Datum the levels on it should be referred. The difference in level involved is generally less than 1 ft., but varies locally.

Profile (S)

The shape of an earthwork or natural feature as determined by a cross-section. A profile gives the shape at the surface only, and should be distinguished from a section (q.v.) which includes also the underlying deposits.

Provenance (*Provenience*)

The meaning of this word is ambiguous and its use in archaeology might well be discontinued. It may mean *either* the place from which an object originally came, *or* the place where it was found. The use of the terms 'place of origin' and 'find-spot' is suggested, in order to avoid confusion.

Representative fraction (S)

The scale of a map expressed in the form of a fraction. Thus, at the scale of 1″ to 1 mile, 1″ on the map represents 1,760 × 36″ on the ground. The representative fraction (R.F.) for this scale is therefore $\frac{1}{1760 \times 36}$ or $\frac{1}{63360}$.

Resection (S)

An operation in plane-tabling whereby the surveyor can plot his own position from three visible points which are already marked on his map.

Restoration

1. Restoring a site to its appearance before excavation, by filling in trenches and replacing turf. (It is in this sense that the word is used on p. 83).

2. Restoring a site to its *original* appearance, by building up fallen walls and banks, cleaning and returfing ditches, and replacing decayed timbers, etc.

3. Repairing and replacing parts of broken and decayed objects.

4. Conjectural completion of a fragmentary object with plaster or other modern filling.

Revetment

A facing of masonry, timber, or turf, designed to retain the material of a bank or barrow.

Scale (S)

The ratio of the distance between two points on a map to the real horizontal distance between the same points on the ground.

Section

1. Any vertical exposure of the soil.

2. A measured drawing of such an exposure (see p. 190).

Silt

The material which gradually fills up ditches, pits, and other depressions under the natural influences of weathering and gravity. Silt is divided into primary and secondary types according to its position (see p. 165). It should be distinguished from filling (s.s.) (q.v.).

Slope distance or slope measurement (S)

The distance between two points, measured along the ground. This should be distinguished from the horizontal distance, which is always less than the slope distance (p. 108). All maps show horizontal distances only.

Spot height (S)

A point on a map at which the height is marked. They should be distinguished from bench marks (q.v.), which, unlike spot heights, refer to actual marks on the ground.

Station (S)
Any point on the ground at which an instrument is set up.

Stratification
The arrangement of strata or layers one above another. Stratification is the chief means of studying the history of an archaeological site.

Stratum
Any well-defined deposit made by human or natural agency; more commonly called a layer.

Structure
See *Find*

Subsoil
Strictly speaking, the layer of soil lying immediately beneath the topsoil (q.v.), into which only the deeper roots penetrate. Archaeologically the word is often used to mean the natural rock or 'natural' (q.v.).

Topsoil
Strictly speaking, the surface layer of the soil in which the grass is rooted. The word is used archaeologically to mean the whole of the soil layer, as distinct from the rock (chalk, gravel, etc.) which it covers.

Traverse (S)
A method of surveying linear detail by means of a framework of connected straight lines (see p. 100).

Triangulation (S)
A method of surveying a series of isolated points by means of compass bearings to and from the ends of one or more base lines (see p. 101).

Tying in (S)
A method of fixing the position of a point by measuring its distance from two known points (see p. 89).

Vertical interval (S)
The vertical interval (V.I.) between contours (q.v.). Thus, with a V.I. of 50 ft., contours will be drawn at 50, 100, 150, 200 ft., and so on above the datum plane.

APPENDIX I

THE CLEANING AND RESTORATION OF FINDS

POTTERY

POTTERY should be washed[1] in clean water only, using a soft brush (a small paint brush is suitable) for loosening the dirt; hot water or soap or abrasives of any kind should never be used. Particular care should be taken to clean thoroughly the broken edges of sherds, so that the internal structure of the fabric may be seen, and to enable close joins to be made between sherds.

Romano-British pottery, which is usually fairly hard and well-fired, can be brushed with some vigour, but care must be taken with colour-coated sherds and those bearing *graffiti* or decoration. All other pottery should be handled delicately, as sherds which have been badly fired or decomposed by an acid soil will often disintegrate if allowed to soak in water.

Very friable sherds should be dipped in a weak (2 to 5 per cent) solution of celluloid in acetone, or celluloid in amyl acetate, and allowed to dry before any attempt is made to remove the dirt. This treatment strengthens the pottery, but does not waterproof it, and care must still be taken to avoid prolonged soaking.

When washed clean, friable sherds should be allowed to dry thoroughly, preferably in a low-temperature oven. They may then be hardened by another application of celluloid.

Building up a pot from broken sherds needs patience and dexterity rather than any special knowledge. Reconstruction should begin with the base, and gaps should be avoided as far as possible, as it is difficult to fit in a sherd after the surrounding parts have already been joined. A box of fine sand, pieces of plasticine, and small sandbags are all useful for supporting the sherds while the glue is drying.

The best cement to use is a subject of controversy, and many workers have their pet formulae. The ideal cement is one that will not become tacky in damp conditions, and yet can be easily softened, so that the fit of sherds can be adjusted during reconstruction. The proprietary cement best fulfilling these conditions is *Durofix*, which

[1] But see p. 141 on the necessity of careful examination before washing.

can be used cold, dries hard, and is impervious to damp; it can be softened by several applications of acetone. It is to be preferred to gelatine-base glues, such as *Seccotine*, which are not waterproof, and tend to congeal in cold weather. The chief disadvantage of *Durofix* is that it joins pottery so well; even when the cement has been softened with acetone great care must be used in separating two sherds for adjustment of the fit, as the cement is often stronger than the fabric of the pottery. To prevent tearing the sherds, the edges to be joined should previously be hardened, either with size (a weak solution of gelatine-base glue), or with celluloid solution. This extra hardening is usually unnecessary where the sherds have already been impregnated with celluloid.

Missing portions of a restored pot may be filled up with plaster-of-paris. A piece of plasticine is moulded to the curve of the outside of the pot, at the same level as the gap, and is moved round to cover it. Plaster is then poured in from the inside and the excess trimmed off before it sets. The plaster should be coloured to match the pot when it is mixed; this gives a better finish than painting with water-colours when the plaster has set. Plaster repairs in thin-walled pots may be strengthened by painting with celluloid solution when dry; large repairs should be reinforced with strips of cloth, canvas, tow, or *non-ferrous* wire.

BONES

Animal and human bones should be washed carefully with water and a soft brush. When thoroughly dry they may be painted with a hot solution of size, which to some extent restores their original gelatine content, and makes them less brittle. Breaks should be mended with gelatine glue, using wooden pegs in the cavity of the bone where necessary, and great care should be taken not to damage the delicate spongy (cancellous) tissue which forms the centre of the thicker bones. It need hardly be added that correct and rapid repair, especially of skulls, requires some knowledge of skeletal anatomy.

WOOD

Ancient wood is usually very decayed, and contains a large amount of water. When this water dries out considerable shrinking and warping takes place, unless the drying is very slow. The simplest method of slow drying is to pack the wood as soon as excavated in a tin, surrounded by several layers of damp moss, and to leave it for about six months with the lid on. Quicker methods of drying,

which involve replacing the contained water by a volatile liquid such as alcohol, should be left to an expert restorer in a museum laboratory.

SHALE AND JET

These materials tend to break up on exposure into numerous laminations. Treatment is a matter for an expert, to whom the objects should be sent as soon as possible after excavation. The packing (e.g. damp moss) should be of the same humidity as the earth in which the objects were lying.

METALS

No attempt should be made by the excavator to clean corroded metal objects, beyond the careful removal of loose surface dirt. On no account should coins be scrubbed or scraped to reveal the inscription. All corroded metal finds should be sent at once for treatment in a museum laboratory.

N.B. So far as possible all cleaning, apart from the removal of superficial dirt, and all restoration, including that of pottery, should be left to a competent museum worker. The above details are given for use when this course is not possible.

APPENDIX II

TREASURE TROVE[1]

IT is always possible that on an excavation some one will turn up an object of gold or silver, and it is therefore desirable that the excavator in charge should be familiar with the law concerning Treasure Trove.

At the time of writing (January 1946) objects of *gold* and *silver*, which have been *hidden* in the soil or in a building with the intention of subsequent recovery, and *of which the owner cannot be traced*, are Treasure Trove, and belong to the Crown. It is therefore an offence for the finder of such objects to retain them. It should be noted that this does not apply to objects of gilt bronze, bronze, or any metal other than gold and silver.

The proper procedure is to report the discovery *at once* to the local coroner, either directly or through the police. It is the coroner's duty to hold an inquest, in order to decide whether the objects found are in fact Treasure Trove, and, if so, who was the finder of them.

If the discovery is reported *promptly*, and if the inquest decides that they are Treasure Trove, the finder is entitled to receive the full market value, if the finds are retained by the Crown or by a museum; if they are not so retained, they will be returned to him to dispose of as he wishes.

It should be noted that any payment made by the excavator-in-charge to one of his workmen, in respect of objects found by him and declared to be Treasure Trove, will not in any way detract from the workman's right as finder to receive either the objects themselves or their market value in cash.

[1] See *Antiquaries Journal*, x (1930), 228.

TABLE I

Scale		Measure to the nearest
1/6 . .	2 in. to 1 ft.	$\frac{1}{10}$ in.
1/12 . .	1 in. to 1 ft.	$\frac{1}{4}$ in.
1/24 . .	1 in. to 2 ft.	$\frac{1}{2}$ in.
1/60 . .	1 in. to 5 ft.	1 in.
1/96 . .	1 in. to 8 ft.	even in.
1/144 . .	1 in. to 12 ft.	$\frac{1}{4}$ ft.
1/192 . .	1 in. to 16 ft.	$\frac{1}{3}$ ft.
1/300 . .	1 in. to 25 ft.	$\frac{1}{2}$ ft.
1/600 . .	1 in. to 50 ft.	1 ft.
1/1200 . .	1 in. to 100 ft.	even ft.
1/2500 . .	25 in. to 1 mile	5 ft.
1/10560 . .	6 in. to 1 mile	20 ft.
1/63360 . .	1 in. to 1 mile	100 ft.

TABLE II   TABLE III

Angle of slope in degrees	Subtract %	Add %
6	$\frac{1}{2}$	$\frac{1}{2}$
7	$\frac{3}{4}$	$\frac{3}{4}$
8	1	1
9	$1\frac{1}{4}$	$1\frac{1}{4}$
10	$1\frac{1}{2}$	$1\frac{1}{2}$
12	$2\frac{1}{4}$	$2\frac{1}{4}$
14	3	3
16	4	4
18	5	$5\frac{1}{4}$
20	6	$6\frac{1}{2}$
25	$9\frac{1}{2}$	$10\frac{1}{4}$
30	$13\frac{1}{2}$	$15\frac{1}{2}$
35	$18\frac{1}{4}$	22

SELECT BIBLIOGRAPHY

VERY little has been written on the technical aspects of field archaeology. This bibliography does not attempt to be comprehensive. The arrangement follows the order of the chapters. The prices quoted are for new copies, and are taken from the *English Catalogue of Books*, but many of the books listed are only obtainable second-hand.

GENERAL

CLARK, GRAHAME. *Archaeology and Society.* Methuen. 1947. 10*s*. 6*d*.

A book for the general reader, excellently illustrated, explaining the application of scientific technique to archaeological problems throughout the world. The last chapter discusses the place of archaeology in the modern community.

DANIEL, G. E. *The Three Ages.* Cambridge University Press. 1943. 3*s*. 6*d*.

A short monograph putting the case for revision of our present nomenclature of archaeological periods.

CRAWFORD, O. G. S. *Man and His Past.* Oxford University Press. 1921. 10*s*. 6*d*.

The best introduction to the principles and background of archaeological research, and an indispensable book for all students. Chapters X–XVI give a valuable account of field-work, and the whole book is a lesson on the importance of maps in archaeology.

KENYON, K. M. *Beginning in Archaeology.* Phoenix House. 1952. 12*s*. 6*d*.

A general introduction for the beginner. The emphasis throughout is on work in the field, and other equally important aspects of archaeology are largely ignored. It contains a useful summary of academic courses in archaeology. For a review, see *Archaeological News Letter*, IV (1952), 120–22.

PETRIE, SIR W. M. FLINDERS. *Methods and Aims in Archaeology.* Macmillan. 1904. 6*s*.

The only detailed text-book of archaeological field methods hitherto published in this country. It is now out of date in some respects, and deals largely with Egypt and the Near East. The general principles enunciated, however, are universally applicable.

FIELD-WORK

ORDNANCE SURVEY. Professional Papers, New Series. No. 13. *Field Archaeology*. H.M. Stationery Office. 3rd edition. 1951. 2*s*. 6*d*.

A short pamphlet describing the types of earthwork and other monuments marked on the maps of the Survey.

ORDNANCE SURVEY. *The Projection for Maps and Plans and the National Reference System*. H.M. Stationery Office. 1951. 1*s*. 3*d*.

A full explanation of the National Grid and how to use it.

BIRCH, T. W. *Maps, Topographical and Statistical*. Oxford University Press. 1949. 15*s*.

GARNETT, ALICE. *The Geographical Interpretation of Topographical Maps*. Harrap. New edition. 1935. 7*s*. 6*d*.

An advanced work on the interpretation of maps, particularly the Ordnance Survey 1-in. Series.

OSWALD, A. 'On watching a Building Site'. *Archaeological News Letter*, II (1949), 57–58.

WILLIAMS-FREEMAN, DR. J. P. *An Introduction to Field Archaeology as illustrated by Hampshire*. Macmillan. 1915. 15*s*.

One of the classics of field archaeology. The first part of the book is concerned with the influence of topography on settlement; the main portion consists of descriptions of Hampshire earthworks, with detailed plans; there is a final section on the measurement and recording of sites.

WINTERBOTHAM, BRIGADIER H. S. L. *A Key to Maps*. Blackie. Second edition. 1939. 5*s*.

An indispensable book for all users of the Ordnance Survey maps, written by a former Director-General of the Survey. It gives full details of the various maps and plans, and descriptions of how they are produced.

AIR-PHOTOGRAPHY

BRADFORD, J. S. P. 'Humanity from the Air'. *Archaeological News Letter*, I, no. 4 (July 1948), 1–5.

CRAWFORD, O. G. S. *Air Survey and Archaeology*. Ordnance Survey Professional Papers, New Series. No. 7. H.M.S.O. 1924. 5*s*.

Air Photography for Archaeologists. Ordnance Survey Professional Papers, New Series. No. 12. H.M.S.O. 1929. 4*s*. 6*d*.

These are the standard works on air-photography in archaeology, written by a pioneer of the subject. Both are fully illustrated with full-page plates.

CRAWFORD, O. G. S., and KEILLER, A. *Wessex from the Air.* Oxford University Press. 1928. 50*s.*

A volume of magnificent air-photographs illustrating the archaeology of Wessex. Each plate is accompanied by explanatory text and a plan interpreting the photograph.

RILEY, D. N. 'The Technique of Air Archaeology.' *Archaeological Journal,* CI, 1.

TROREY, L. G. *Handbook of Aerial Mapping and Photogrammetry.* Cambridge University Press. 1950. 25*s.*

Useful for the mathematically-minded field-worker who wishes to plot from air-photographs.

PREHISTORIC GEOGRAPHY

DARBY, H. C. *An Historical Geography of England before A.D.* 1800. Cambridge University Press. 1936. 25*s.*

FOX, SIR CYRIL. *The Personality of Britain.* National Museum of Wales, Cardiff. Fourth edition, 1943. 5*s.*

A book which should be read by every student of British Archaeology.

NORTH, F. J. 'Geology for Archaeologists.' *Archaeological Journal,* XCIV, 73.

TANSLEY, A. G. *The British Islands and their Vegetation.* Cambridge University Press. 1950. 63*s.*

The standard work for the study of the primitive distribution of vegetation-types.

WOOLDRIDGE, S. W. and LINTON, D. L. 'The Loam-Terrains of South-east England and their Relation to its Early History.' *Antiquity,* VII, 297.

'BOSING'

CURWEN, E. C. *Antiquity,* II, 258; IV, 30.

'The Detection and Mapping of Earthworks.' *Prehistoric Sussex,* p. 147. Homeland Association. 1929.

EXCAVATION

ATKINSON, R. J. C. 'Excavating and the Amateur.' *Archaeological News Letter,* I, no. 3 (June 1948), 1–2.

DROOP, PROFESSOR J. P. *Archaeological Excavation.* Cambridge University Press. 1915. 6*s.*

The only book on excavation so far published in England. It contains a good description of the principles of stratigraphy and its interpretation. The last chapter, on women as excavators, has gained unconscious humour since its publication.

DUNCAN, K. M. 'The Excavation of Prehistoric Sites.' *Devon Archaeological Exploration Society,* I, 35.

GOODWIN, A. J. H. *Method in Prehistory.* South African Archaeological Society (Cape Town). 1945.

This excellent manual, though written with special reference to Palaeolithic sites in South Africa, contains much that can profitably be applied to similar and later sites in the Northern Hemisphere.

OXFORD UNIVERSITY ARCHAEOLOGICAL SOCIETY. *Notes on Archaeological Technique.* Ashmolean Museum. 3rd edition. 1950. 1*s.* 6*d.*

PITT-RIVERS, LIEUT.-GENERAL A. H. L-F. *Excavations.* 4 vols. Privately printed and issued. 1887–98.

These volumes are classics of archaeological research. They illustrate the methods introduced by Pitt-Rivers and followed by all subsequent workers, and contain, especially in the Prefaces, many profound statements of principle expressed in a characteristic style.

WHEELER, COMMANDER N. F. 'Excavation.' *Antiquity,* IV, 173–9.

WHEELER, R. E. M. 'Further Notes on Digging and Recording.' *Ancient India,* IV (1947–48), 311–21.

POLLEN ANALYSIS

ERDTMAN, G. *An Introduction to Pollen Analysis.* Dawson. 1943. 25*s.*

FAEGRI, K. and IVERSEN, J. *Text Book of Modern Pollen Analysis.* Munksgaard (Copenhagen), 1950.

ZEUNER, F. E. *Dating the Past.* Methuen. 2nd edition. 1950. Chap. III, B, with full bibliography.

SURVEYING

D'AGAPEYEFF, A., and HADFIELD, E. C. R. *Maps.* Oxford University Press. New edition. 1950. 6*s.*

Chapters I–IV describe briefly the main principles of surveying; the remainder of the book deals with map projections and the history of maps. Chapter X gives a short history of the Ordnance Survey.

DEBENHAM, PROFESSOR F. *Map Making*. Blackie. Second edition. 1940. 5*s*.

A very good text-book of simple surveying, written specially for the amateur. It should be read by every beginner in archaeological field-work.

DETWEILER, A. H. *Manual of Archaeological Surveying*. American Schools of Oriental Research. 1948.

For a Review of this book, see *Antiquity*, XXIV (1950), 166.

HIGGINS, A. L. *Elementary Surveying*. Longmans Green. 1943. 6*s*.

A first text-book, primarily addressed to the would-be professional surveyor.

LOCKYER, SIR NORMAN. *Surveying for Archaeologists*. Macmillan. 1909. 4*s*.

This book is, perhaps, misnamed, as it deals only with one application of surveying to archaeology, namely, determination of the orientation of Megalithic and other monuments.

MIDDLETON, R. E., and CHADWICK, O. *A Treatise on Surveying*. 2 vols. Spon. Fifth edition. 1941. 21*s*.

This work deals exhaustively with all aspects of surveying; it gives useful instructions for the use and adjustment of many kinds of instrument.

PHOTOGRAPHY

CHARLES, D. *Photographers and the Law*. Iliffe. 1950. 7*s*. 6*d*.

COOKSON, M. B. 'Archaeological Photography.' *Ancient India*, II (1946), 134–7.

'Photography in Archaeology.' *Archaeological News Letter*, III (1951), 191–5; *ibid.*, IV (1951), 11–13, 23–6.

Expert advice, based on years of experience, by the leading British archaeological photographer.

CRAWFORD, O. G. S., and others. 'Archaeological Photography.' *Antiquity*, II, 351, 486.

FRANTZ, A. 'Truth before Beauty, or the Incompleat Photographer.' *Archaeology* (New York), III (1950), 202–14.

Gives useful advice on lighting and backgrounds for photographing finds in the field and museum.

MINIATURE CAMERA MAGAZINE. *Data Book of Facts and Formulae*. Telephoto Press. 1941. 5*s*.

FOCAL PRESS. Fitzroy Square, W.1.

Many excellent publications, too numerous to list here, on all branches of photography. These books are notable for their clear diagrams and illustrations.

SMITH, F. H. *Photographs and the Printer.* Focal Press. 1948. 12*s*. 6*d*.

A practical guide to the preparation of photographs for reproduction by the half-tone and other processes.

INTERPRETATION

FORDE, PROFESSOR C. DARYLL. *Habitat, Economy and Society.* Methuen. Sixth edition. 1948. 18*s*.

A survey of selected types of modern primitive community, illustrating the effect of environment upon social and economic organization.

SAYCE, R. U. *Primitive Arts and Crafts.* Cambridge University Press. 1933. 8*s*. 6*d*.

A survey of material culture among modern primitive peoples. This and the last work are recommended as an introduction to cultural anthropology and as aids to the understanding and interpretation of archaeological evidence.

ZEUNER, F. E. *Dating the Past.* Methuen. 2nd edition. 1950. 30*s*.

A comprehensive survey of the various methods used in chronological studies, including dendrochronology and soil and pollen analysis, with tables of Pleistocene and post-Glacial chronology.

COINS

MATTINGLY, H., and SYDENHAM, E. A. *The Roman Imperial Coinage.* 5 vols. 1923–33. £8 16*s*.

The standard English work on Roman coins.

O'NEIL, B. H. ST. J. 'Coins and Archaeology in Britain.' *Archaeological Journal*, XCII, 64.

An article explaining the methods and difficulties of coin-interpretation. It should be read by every excavator who has coins among his finds.

PUBLICATION

COLLINS, F. HOWARD. *Authors' and Printers' Dictionary.* Oxford University Press. 1947. 7*s*. 6*d*.

HART, H. *Rules for Compositors and Readers.* Humphrey Milford. 35th edition. 1950. 5*s.*

Two works of reference useful for ambiguous spellings and for the signs used in the correction of proofs.

TRELEASE, S. F., and YULE, E. S. *Preparation of Scientific and Technical Papers.* Williams and Wilkins, Baltimore, U.S.A. 1937. 7*s.*

A short American work describing the technical processes involved in the preparation, illustration, and publication of reports. It should be noted that some of the proof-correction signs given are different from those of English practice.

DRAWING

DEBENHAM, PROFESSOR F. *Exercises in Cartography.* Blackie. 1937. 8*s.* 6*d.*

SMITH, H. P. *Drawing and Tracing.* Crosby Lockwood. 1939. 2*s.* 6*d.*

A short text-book for commercial draughtsmen.

WHEELER, R. E. M. 'The Recording of Archaeological Strata.' *Ancient India*, III (1947), 143–50.

This article should be read and digested by every field archaeologist who has to draw sections.

LETTERING

HIGGINS, W. *Pen Practice.* Batsford. Second edition. 1939. 1*s.* 6*d.*

Practical exercises in round-hand and similar styles of pen-lettering.

JOHNSTONE, E. *Writing and Illuminating and Lettering.* Pitman. 1942. 8*s.* 6*d.*

One of the most comprehensive books on all styles of lettering.

THOMAS, D. *A Book of Printed Alphabets.* Sidgwick and Jackson. 1946. 7*s.* 6*d.*

A selection of modern printers' types, suitable as models for formal styles and for tracing direct.

PRESERVATION

PLENDERLEITH, DR. H. J. *The Preservation of Antiquities.* Museums Association. 1934. 3*s.* 6*d.*

ULLAH, KHAN BAHADUR MOHD. SANA. 'Notes on the Preservation of Antiquities in the Field.' *Ancient India*, I (1946), 77–82.

UNWIN, MAX. 'The Uses of Plastics and Other New Materials in Archaeology.' *Archaeological News Letter*, III (1951), 175–8.

BRITISH ARCHAEOLOGY

CHILDE, PROFESSOR V. G. *Man Makes Himself*. Watts. New edition. 1951. 3*s*. 6*d*.

CLARK, GRAHAME. *Prehistoric England*. Batsford. 1940. 8*s*. 6*d*.

HAWKES, J. *A Guide to the Prehistoric and Roman Monuments in England and Wales*. Chatto and Windus. 1951. 18*s*.

HAWKES, J., and HAWKES, C. F. C. *Prehistoric Britain*. Pelican Books (A115). 1943. 2*s*.

HAWKES, J., and HAWKES, C. F. C. *Prehistoric Britain*. Chatto and Windus. New edition. 1947. 15*s*.

CHILDE, PROFESSOR V. G. *Prehistoric Communities of the British Isles*. Chambers. New edition. 1947. 25*s*.

KENDRICK, T. D., and HAWKES, C. F. C. *Archaeology in England and Wales*, 1914–31. Methuen. 1932. 18*s*.

PIGGOTT, S. *British Prehistory*. Home University Library (Oxford University Press). 1950. 5*s*.

These eight titles are added for the reader who desires an introduction to the subject-matter of British Archaeology. The first five are written for the general reader; the last three are text-books for the serious student, with full bibliographies for further reading,

INDEX

PLATES

I

AIR-PHOTOGRAPH OF BURDEROP DOWN, CHISELDON, WILTS.

A shadow-site (p. 19), showing banks or 'lynchets' dividing the slope of the hill into rectangular plots typical of the 'Celtic' field-system. On the right is a D-shaped enclosure, whose ditch cuts through, and is therefore later than, the 'Celtic' fields. Note how the white rabbit-scrapes are confined to the looser soil forming the banks.

II

AIR-PHOTOGRAPH OF FOXLEY FARM, NEAR EYNSHAM, OXFORD

A crop-site (p. 20), showing two kinds of crop-mark. In the farther field the crop is still green, and the position of the ditches is shown by a darker tone. In the nearer field the crops are ripe and uniform in colour, but over the ditches there is sufficient extra growth to cast a shadow. Taken July 4th.

III

AIR-PHOTOGRAPH OF THE ROMAN VILLA SITE, DITCHLEY, OXON.

(*Oxoniensia*, I, 24)

A crop-site (p. 20) showing marks of two kinds. The light lines indicate the position of walls, whose hard surface hinders the growth of the crop, thus allowing the lighter-toned soil to show through. The dark lines appear over silted ditches. Taken June 16th.

IV

AIR-PHOTOGRAPH OF PIMPERNE DOWN, DORSET

In the foreground a boundary ditch and a group of small mounds are shown by shadows, as are also a long barrow and modern cart-tracks in the field on the right, the latter overlying 'Celtic' fields. In the centre is a heart-shaped enclosure ditch, indicated as a dark line varying in tone according to the nature of the different crops. In the top left-hand plot, containing the hay-stack, the soil is bare, and the same ditch appears as a soil-mark (p. 21), the white tone of the ploughed-down bank contrasting with the darker tone of the ditch-filling. Taken August 9th.

V

(*a*) EXCAVATIONS AT MAIDEN CASTLE, DORSET

The cuttings are laid out on the 'box' system (p. 50, fig. 9), with intervening baulks of sufficient width to accommodate a wheelbarrow.

(*b*) BAD EXCAVATION

The trench has been cut by eye alone; the edges are ragged, the sides sloping, and the roots have not been trimmed off. The turf has been torn up with a fork and mixed with the soil in the dump. The dump has been trampled, and is falling back into the trench.

VI

(*a*) EXCAVATION OF A ROUND BARROW, LLANDOW, GLAM.

The cuttings are planned on a modification of the quadrant system (p. 73, fig. 16). Note the use of ranging-poles, and the very neat appearance resulting from the removal of the excavated soil to dumps outside the area of work.

(*b*) A LATER STAGE IN THE EXCAVATION OF THE SAME BARROW

VII

(*a*) THE USE OF THE TROWEL: method 2 (p. 47).

(*b*) THE USE OF THE TROWEL: method 4 (p. 48).

VIII

EXCAVATIONS AT MAIDEN CASTLE, DORSET

The numbered pegs are placed at the sides of the trench for reference purposes (p. 144). The section shows a good example of the rubble material typical of chalk sites. The man stands in a Neolithic ditch which is sealed by a dark turf-line at the level of his shoulder. The superimposed mound is of Iron Age date.

IX

STEREOSCOPIC EXAMINATION OF AIR-PHOTOGRAPHS

The two prints of the 1/10,000 national air survey (p. 23), showing Maiden Castle, Dorset, and the area to the north of the hill-fort; are correctly orientated beneath the stereoscope, with the light falling from the front; the print- and sortie-numbers (p. 24) can be seen in the upper margins. The stereoscope has folding legs and gives a magnification of two diameters; it can be adjusted to suit the separation of the observer's eyes. (*Air-photographs Crown copyright reserved*).

X

RESISTIVITY SURVEYING

The Megger Earth Tester set up for use. In the foreground is the instrument on its tripod; on its left side is the generator-handle, on top the calibrated dial and a magnifier, and on the right the special switch-gear devised by the author for continuous readings, using a fifth electrode (p. 38). Insulated wires lead from the instrument to the electrodes, which are set up at equal intervals along a measuring-tape.

XI

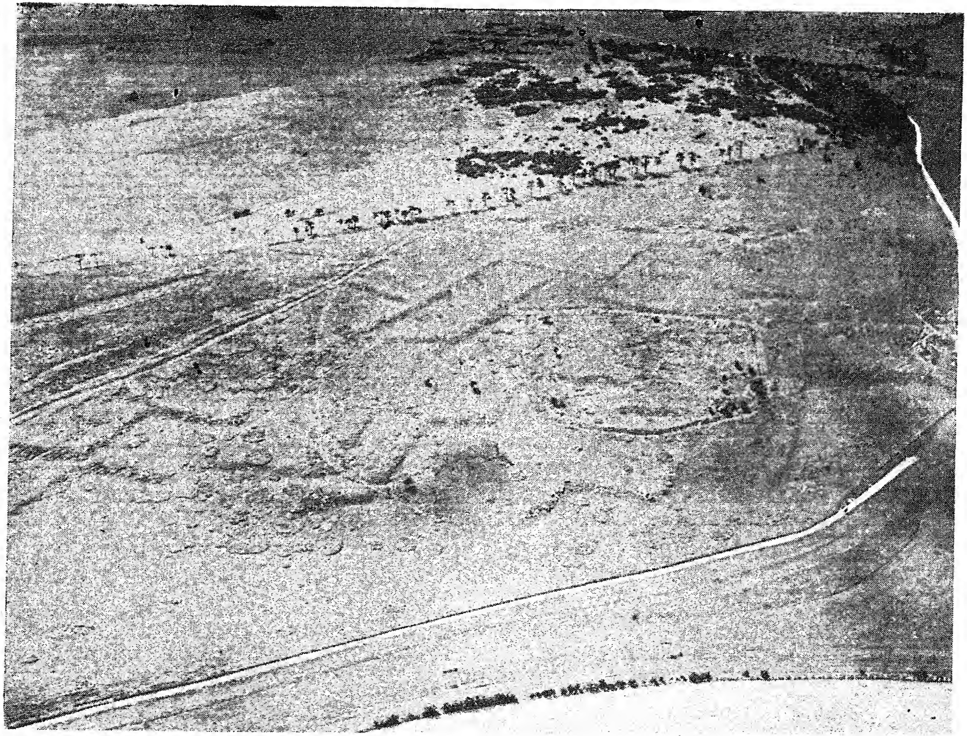
ARCHAEOLOGICAL PHOTOGRAPHY: THE EFFECT OF HEIGHT

Three views of a neolithic cremation-cemetery at Dorchester, Oxon., after excavation. The photographs were taken at heights of 5 ft., 10 ft., and 22 ft. vertically above the same point on the ground; only the highest view-point gives an adequate picture of the site.

XII

PHOTOGRAPHY OF EXCAVATIONS

The portable ladder was built of aluminium alloy to the writer's specification, for the photography of excavations. The ladder is in three sections, and can be extended to a maximum vertical height of 27 ft. For transport, it folds flat between the wheels, and can be moved by one person.



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I

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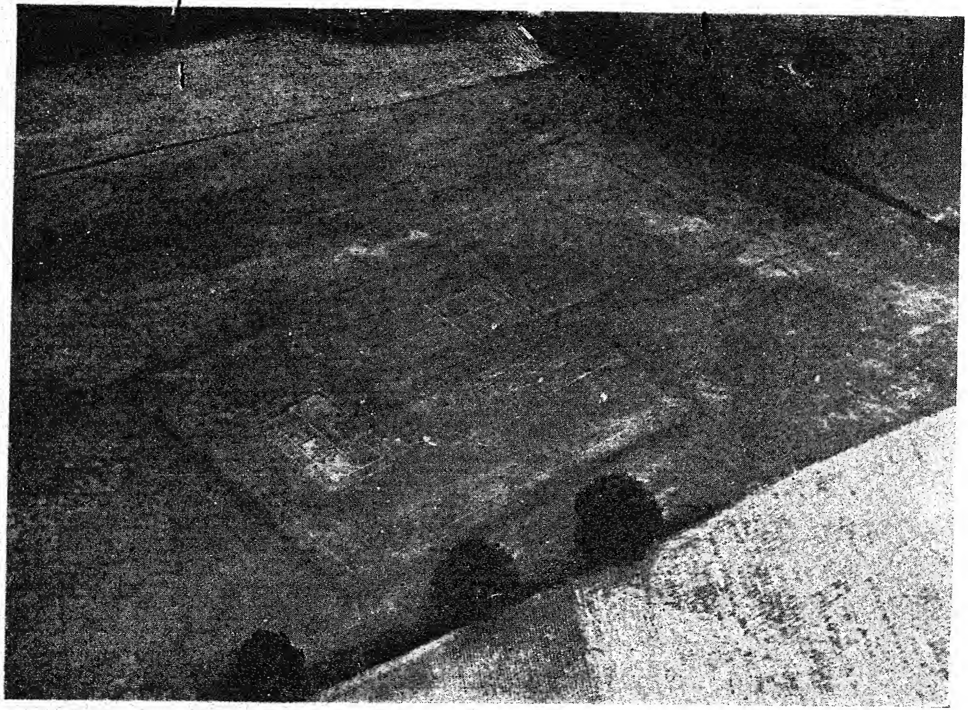
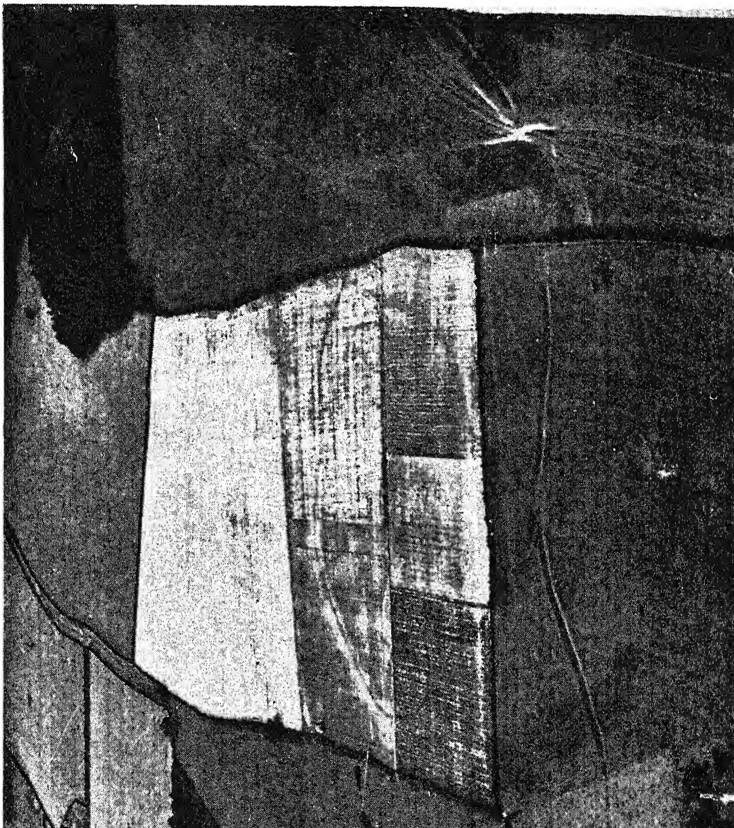


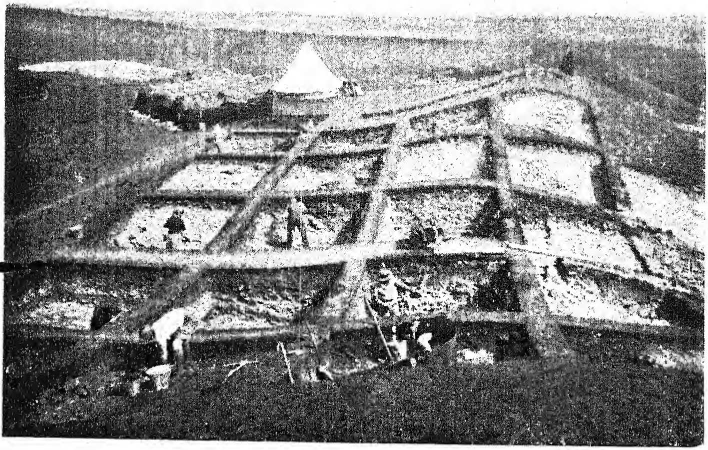
AIR-PHOTOGRAPH OF THE ROMAN VILLA SITE, DITCHLEY, OXON.

III

IV

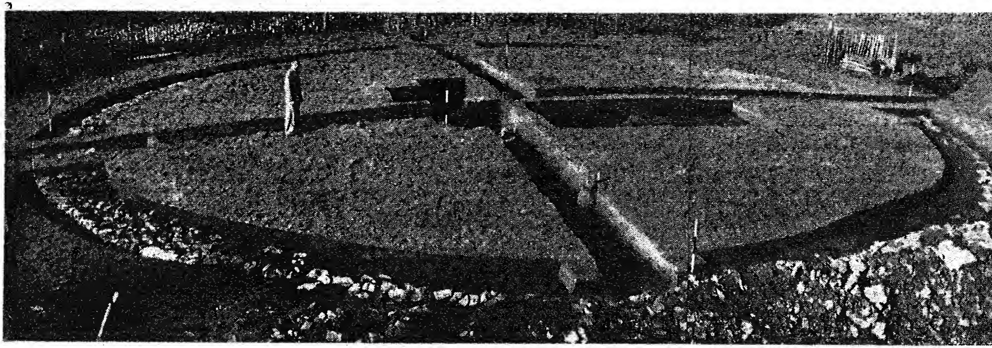


AIR-PHOTOGRAPH OF PIMPERNE DOWN, DORSET



(*a*) EXCAVATIONS AT MAIDEN CASTLE, DORSET

(*b*) BAD EXCAVATION



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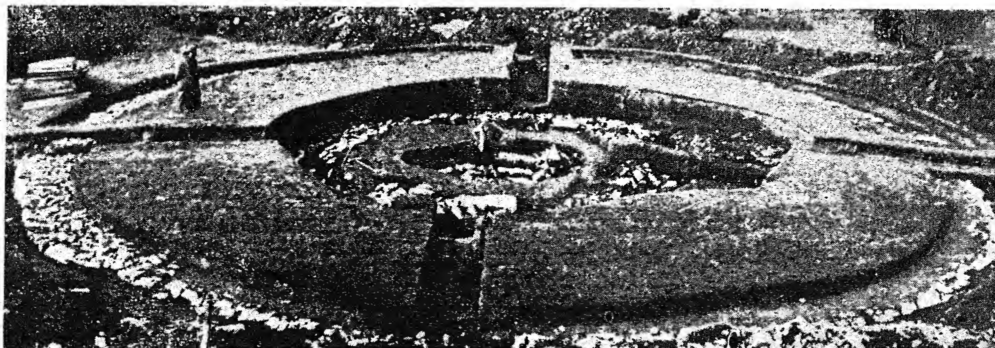
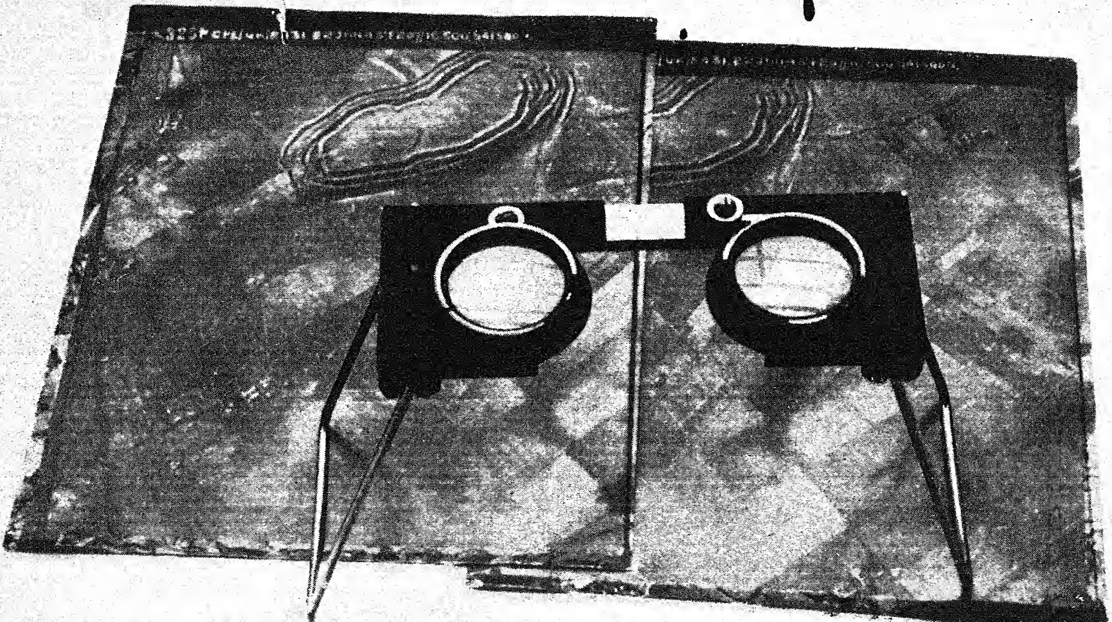


(*b*) A LATER STAGE IN THE EXCAVATION OF THE SAME BARROW

VIII

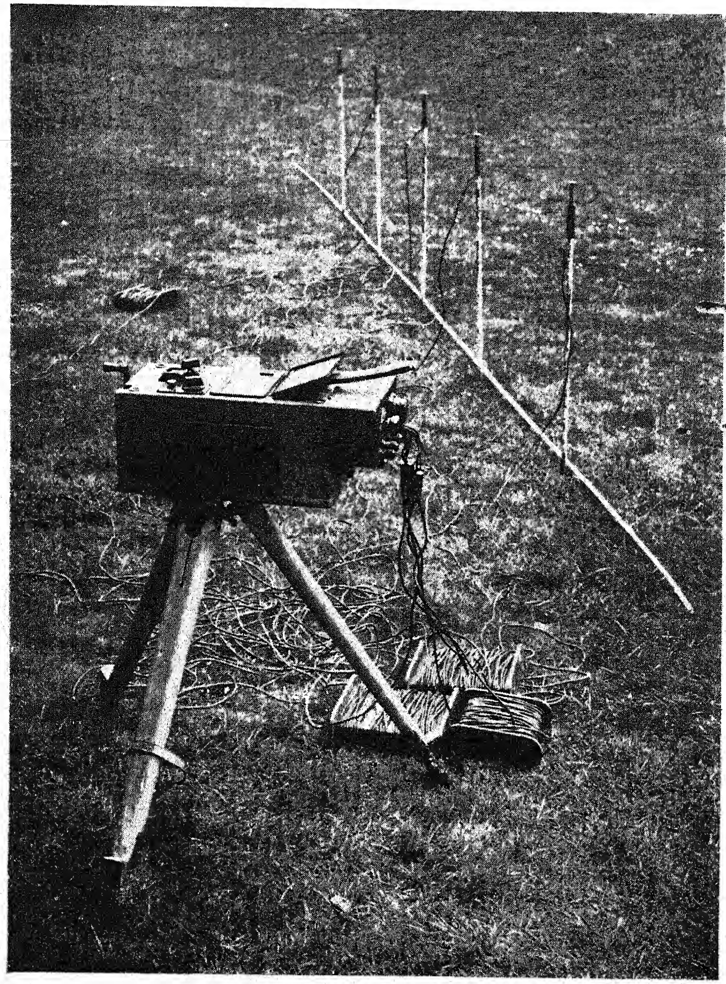
EXCAVATIONS AT MAIDEN CASTLE, DORSET



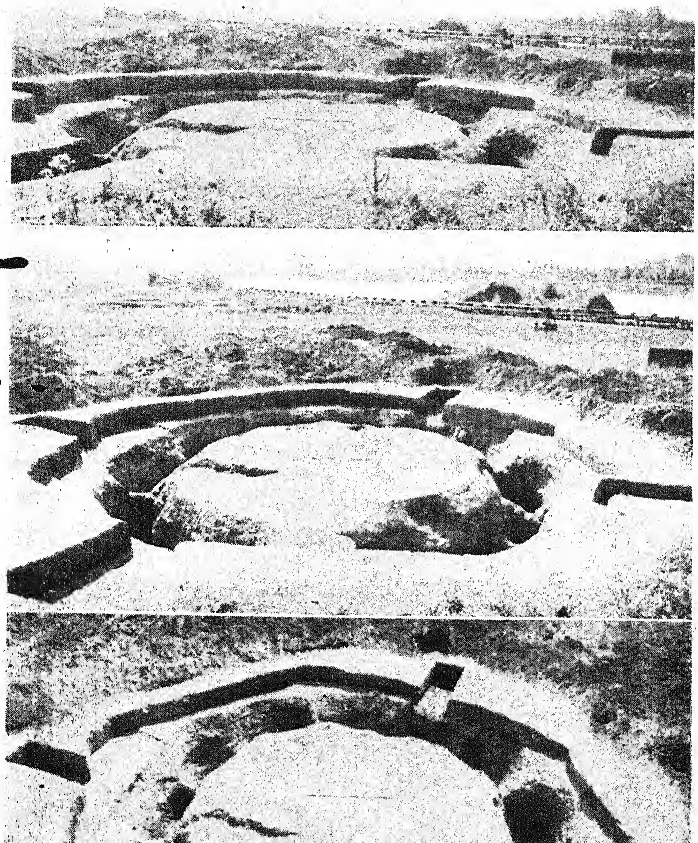
STEREOSCOPIC EXAMINATION OF AIR-PHOTOGRAPHS

IX

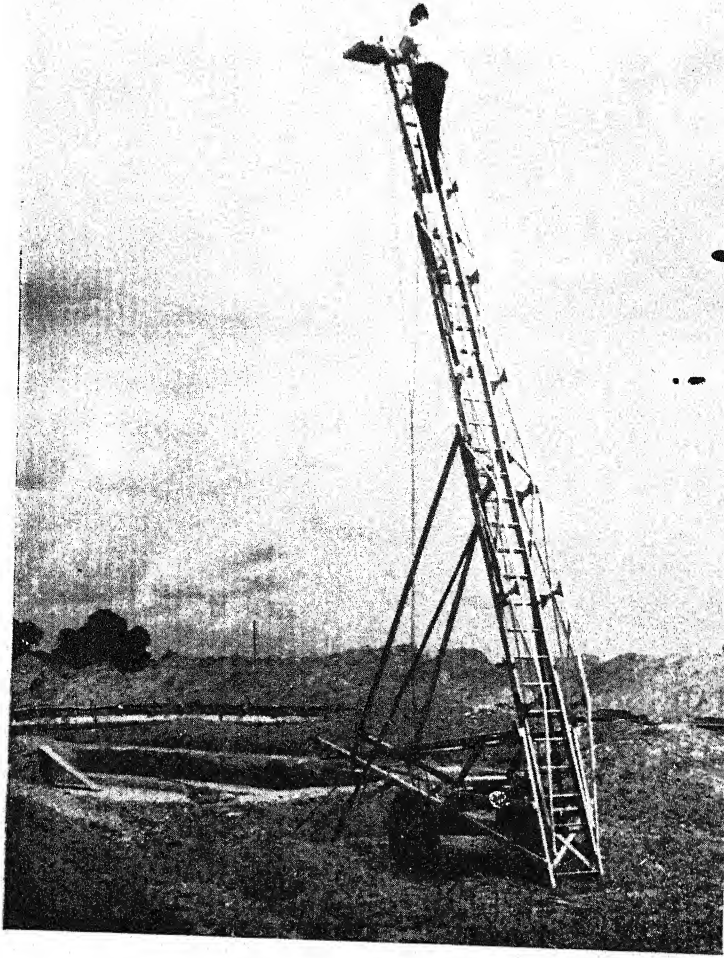
X



RESISTIVITY SURVEYING



ARCHAEOLOGICAL PHOTOGRAPHY:



PHOTOGRAPHY OF EXCAVATIONS